Introduction

In this section, the lessons focus on identifying, classifying, describing, and comparing plane figures. Students determine similarity and congruence of figures and work with transformations. These lessons form an outline for your ARI classes, but you are expected to add other lessons as needed to address the concepts and practice the skills introduced in the ARI Curriculum Companion.

Some of the lessons cross grade levels, as indicated by the SOL numbers shown below. This is one method to help students connect the content from grade to grade and to accelerate.

For the lessons in this section, you will need the materials listed at right.

MATERIALS SUMMARY

Centimeter rulers
Colored pencils
D-stix™, Geo-strips™, or toothpicks with marshmallows
Geoboard dot paper
Geoboards
Graph paper
Music
Patty paper or tracing paper
Pencils
Permanent markers
Protractors
Rubber bands
Rulers
Scientific calculators
Scrap paper
Sets of rectangles
Sets of tangrams
String
Tagboard
Tape
Wire hangers

Standards of Learning

The following Standards of Learning are addressed in this section:

5.15 The student, using two-dimensional (plane) figures (square, rectangle, triangle, parallelogram, rhombus, kite, and trapezoid) will
- a) recognize, identify, describe, and analyze their properties in order to develop definitions of these figures;
- b) identify and explore congruent, noncongruent, and similar figures;
- c) investigate and describe the results of combining and subdividing shapes;
- d) identify and describe a line of symmetry; and
- e) recognize the images of figures resulting from geometric transformations such as translation (slide), reflection (flip), or rotation (turn).

6.14 The student will identify, classify, and describe the characteristics of plane figures, describing their similarities, differences, and defining properties.

6.15 The student will determine congruence of segments, angles, and polygons by direct comparison, given their attributes. Examples of noncongruent and congruent figures will be included.

7.9 The student will compare and contrast the following quadrilaterals: parallelogram, rectangle, square, rhombus, and trapezoid. Deductive reasoning and inference will be used to classify quadrilaterals.

7.10 The student will identify and draw the following polygons: pentagon, hexagon, heptagon, octagon, nonagon, and decagon.

7.11 The student will determine if geometric figures — quadrilaterals and triangles — are similar and write proportions to express the relationships between corresponding parts of similar figures.

7.13 The student, given a polygon in the coordinate plane, will represent transformations — rotation and translation — by graphing the coordinates of the vertices of the transformed polygon and sketching the resulting figure.

8.8 The student will apply transformations (rotate or turn, reflect or flip, translate or slide, and dilate or scale) to geometric figures represented on graph paper. The student will identify applications of transformations, such as tiling, fabric design, art, and scaling.

Table of Contents

The following lessons are included in this section. Click (or CTRL+click) on each to jump to that lesson.

✱ SOL 5.15a

Prerequisite SOL

None

Lesson Summary

Students analyze properties of polygons to develop definitions of *square, rectangle, parallelogram, rhombus, kite,* and *trapezoid,* using geoboards. (45 minutes)

Materials

"Quadrilateral Concept Card"
Geoboards and an overhead geoboard
Geoboard dot paper (attached)
"Quadrilateral Study Guide" worksheets
"Quadrilateral Table" worksheets

Vocabulary

polygon. A simple, closed, plane figure formed by three or more straight lines.
quadrilateral. A closed, two-dimensional figure with four sides that are line segments; a polygon with four sides.
parallelogram. A quadrilateral with two pairs of parallel sides.
rectangle. A parallelogram with four right angles.
rhombus. A parallelogram with four congruent sides.
square. A rectangle with four sides of equal length.
trapezoid. A quadrilateral with exactly one pair of parallel sides.

Warm-up

Give each student a "Quadrilateral Concept Card." Have students follow along as you read and discuss each of the statements. Based on the information given on the concept card and the class discussion, have students draw their own examples of a polygon, non-polygon, quadrilateral, and non-quadrilateral. Have students also write their own definitions, based on their understanding of the words in context. When students are finished, have them share their card with a partner. Bring the class together, and go over the students' responses. Read the definitions of *polygon* and *quadrilateral* (see above) to the class, and allow students to change their definitions to make them more accurate, as necessary.

Lesson

1. Display on the overhead geoboard several four-sided figures. Ask students to identify what they all have in common. (The number of sides) Instruct students that all four-sided figures are called *quadrilaterals*. Focus on the prefix *quad,* and brainstorm other words to help with meaning.
2. Hand out geoboards and rubber bands, and review class rules about working with these materials. Allow the students to explore shapes with the geoboards for a few minutes.
3. Have students make a shape on their geoboard that is a quadrilateral with both pairs of opposite sides parallel and equal in length. Make this shape on the overhead geoboard. Discuss the properties of this figure: it has four sides, both pairs of opposite sides are parallel, opposite sides are congruent, opposite angles are congruent, a diagonal divides the shape into two congruent triangles. Tell the students that the name for this figure is **parallelogram**. Hand out dot paper, and have students copy their figure (or yours, if theirs was incorrect) on the dot paper and label it "parallelogram."
4. Have students make a **rectangle** on their geoboard. When they finish, make one on the overhead geoboard. Discuss the properties of a rectangle: it is a parallelogram with four right angles. Have students copy their rectangle on dot paper and label it "rectangle."
5. Ask for a volunteer to make a **square** on the overhead geoboard. Discuss the properties of a square: it has all of the properties of a parallelogram, and it is also a rectangle with four congruent sides. Have students copy the square on dot paper and label it "square."

6. Ask students to make a **rhombus** on their geoboard, and replicate it on the overhead. Guide students to discover that a rhombus has the properties of a parallelogram, that it has four congruent sides, and that opposite angles of a rhombus are congruent. Have the students label their figure "rhombus."
7. Ask students to make a four-sided shape on their geoboard with only one pair of opposite sides parallel. Ask whether anyone knows the name of this figure. Tell students that it is a **trapezoid** — a four-sided figure with exactly one pair of parallel sides.
8. Have individual students come to the overhead geoboard and create different types of quadrilaterals — rectangle, square, parallelogram, rhombus, and trapezoid — to review the properties and definitions of these quadrilaterals.
9. Have pairs of students complete the "Quadrilateral Study Guide." Provide assistance as needed.

Reflection

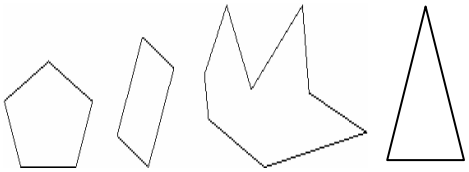
Have students complete the "Quadrilateral Table" worksheet.

Name: _____

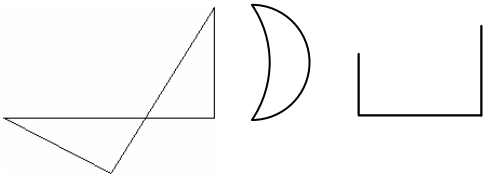
Quadrilateral Concept Card

Polygons

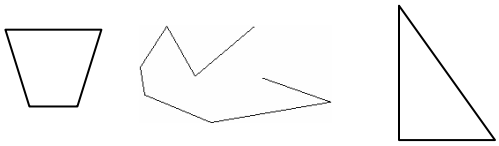
These figures are polygons:



These figures are not polygons:



Which of these figures are polygons? (circle)



Draw your own example of a polygon.

Draw your own example of a non-polygon.

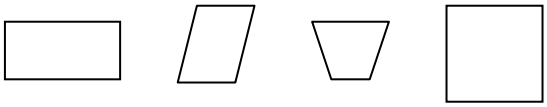
What is a polygon?

A polygon is _____

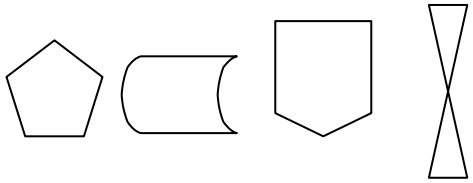
_____.

Quadrilaterals

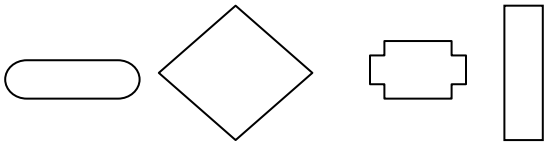
These figures are quadrilaterals:



These figures are not quadrilaterals:



Which of these figures are quadrilaterals? (circle)



Draw your own example of a quadrilateral.

Draw your own example of a non-quadrilateral.

What is a quadrilateral?

A quadrilateral is _____

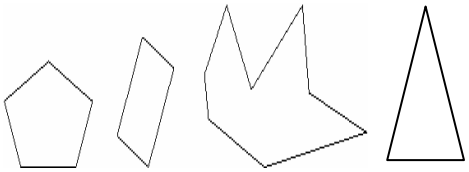
_____.

Name: ANSWER KEY

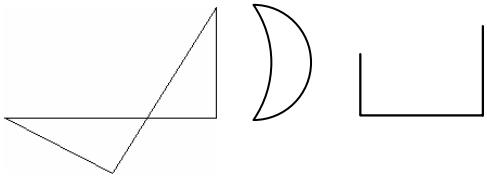
Quadrilateral Concept Card

Polygons

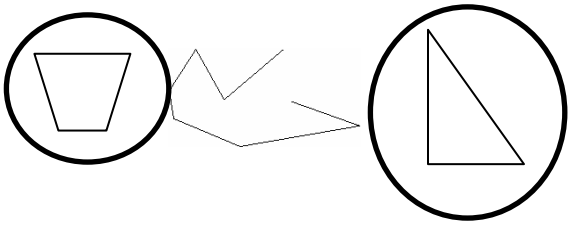
These figures are polygons:



These figures are not polygons:



Which of these figures are polygons? (circle)

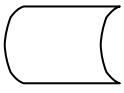


Draw your own example of a polygon.

Drawing will vary.

Draw your own example of a non-polygon.

Drawing will vary. Sample answer:

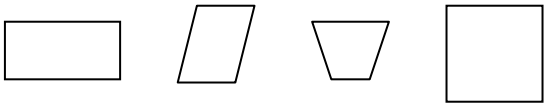


What is a polygon? Sample answer:

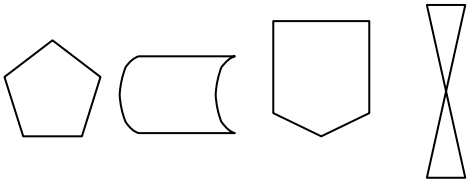
A polygon is a simple, closed, plane figure formed by three or more straight lines.

Quadrilaterals

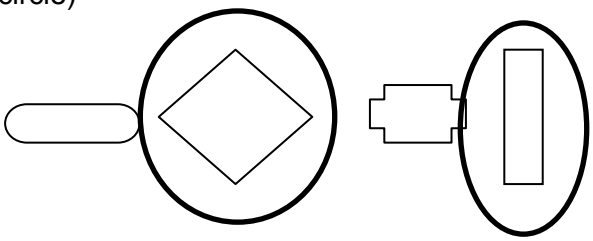
These figures are quadrilaterals:



These figures are not quadrilaterals:



Which of these figures are quadrilaterals? (circle)



Draw your own example of a quadrilateral.

Drawing will vary.

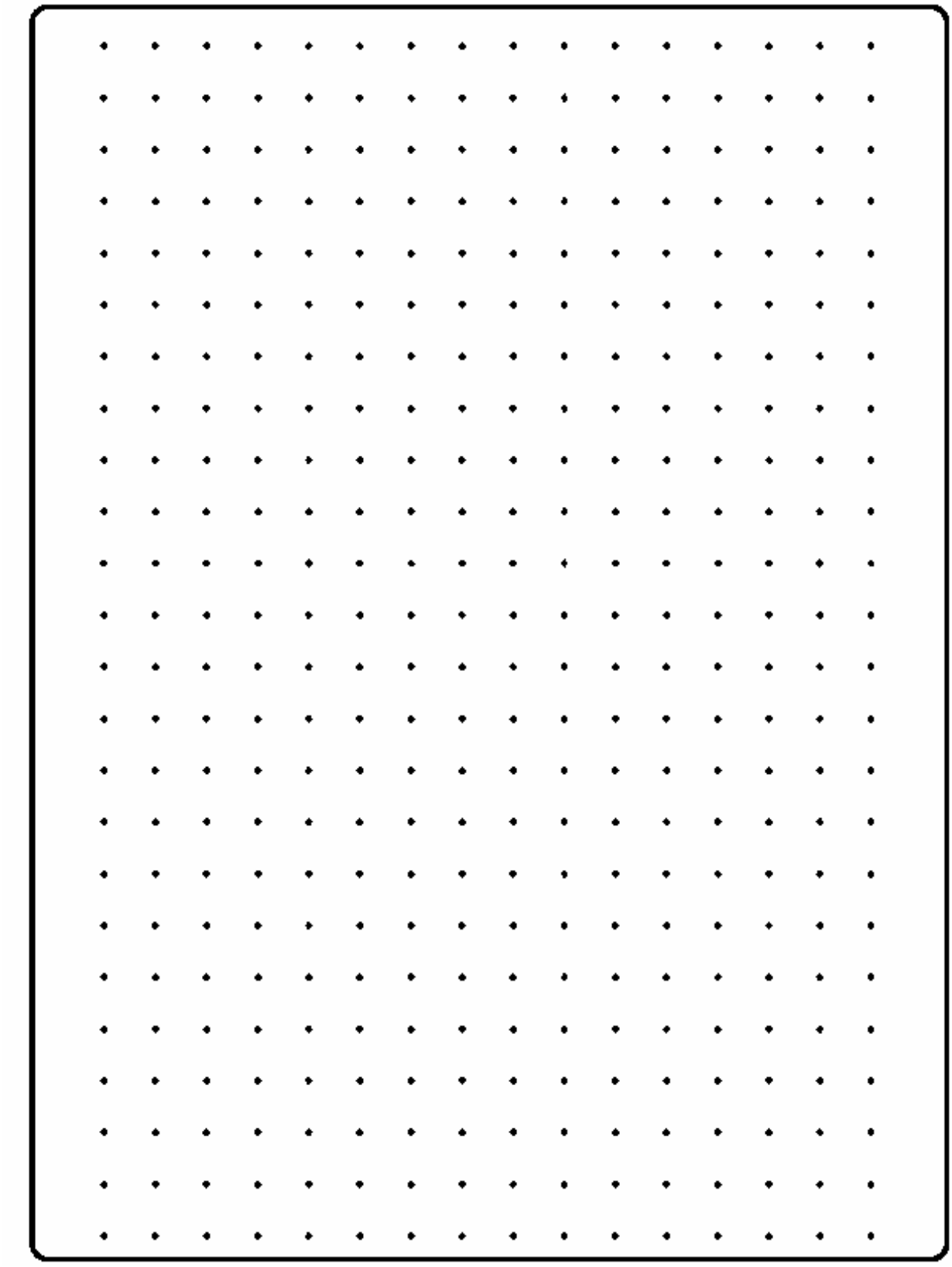
Draw your own example of a non-quadrilateral.

Drawing will vary. Sample answer:

What is a quadrilateral? Sample answer:

A quadrilateral is a four-sided polygon.

Dot Paper



Name: _____

Quadrilateral Study Guide

Fill in the blanks, and draw the figures as directed.

1. A _____ is a polygon with four sides. Draw several examples of this below.

2. A _____ is a quadrilateral in which both pairs of opposite sides are parallel.

3. Properties of a parallelogram include the following:

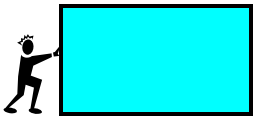
   a. A diagonal divides a parallelogram into two congruent _____.

   b. The opposite sides of a parallelogram are _____.

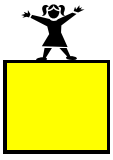
   c. The opposite angles of a parallelogram are _____.

For questions 4–8, refer to the drawings on the right.

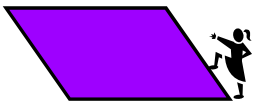
4. A _____ is a parallelogram with four right angles. Since a _____ is a parallelogram, it has the same properties as those of a parallelogram.



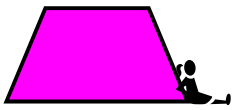
5. A _____ is a rectangle with four congruent sides. Since a _____ is a rectangle, it has all the properties of a rectangle and of a parallelogram.



6. A _____ is a parallelogram with four congruent sides. Opposite angles of a _____ are congruent. Since a _____ is a parallelogram, it has all the properties of a parallelogram.



7. A _____ is a quadrilateral with exactly one pair of parallel sides.



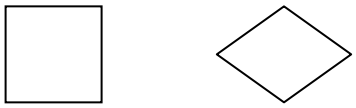
8. A _____ is a quadrilateral with two distinct pairs of adjacent congruent sides. Its diagonals are perpendicular. Draw this figure below.

Name: ANSWER KEY

Quadrilateral Study Guide

Fill in the blanks, and draw the figures as directed.

1. A quadrilateral is a polygon with four sides. Draw several examples of this below.



2. A parallelogram is a quadrilateral in which both pairs of opposite sides are parallel.

3. Properties of a parallelogram include the following:

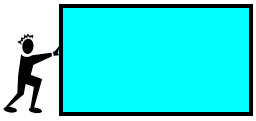
   a. A diagonal divides a parallelogram into two congruent triangles.

   b. The opposite sides of a parallelogram are parallel/congruent.

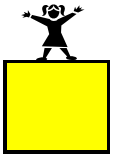
   c. The opposite angles of a parallelogram are congruent.

For questions 4–8, refer to the drawings on the right.

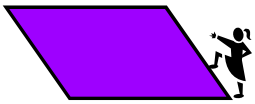
4. A rectangle is a parallelogram with four right angles. Since a rectangle is a parallelogram, it has the same properties as those of a parallelogram. (Discuss with students that *square* also fits this definition, since a square is a special type of rectangle.)



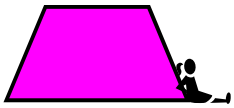
5. A square is a rectangle with four congruent sides. Since a square is a rectangle, it has all the properties of a rectangle and of a parallelogram.



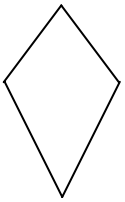
6. A rhombus is a parallelogram with four congruent sides. Opposite angles of a rhombus are congruent. Since a rhombus is a parallelogram, it has all the properties of a parallelogram. (Discuss with students that a square is a special rhombus, so it also fits this definition, but a square must have four right angles.)



7. A trapezoid is a quadrilateral with exactly one pair of parallel sides.



8. A kite is a quadrilateral with two distinct pairs of adjacent congruent sides. Its diagonals are perpendicular. Draw this figure below.



Name: _____

Quadrilateral Table

Place a check mark in the appropriate boxes to show which figures have which properties. Then answer the questions that follow.

PROPERTY OF FIGURE	**TYPES OF POLYGONS**						
	Quadrilateral	**Parallelogram**	**Rectangle**	**Rhombus**	**Square**	**Trapezoid**	**Kite**
Only one set of parallel sides							
Two sets of parallel sides							
Two sides of equal length							
Four sides of equal length							
Four angles of equal measure							
All four angles are right angles							
It may contain a right angle							

Is a square a rectangle? _____ How do you know this? _____

I have four sides and two sets of equal sides, but not all four of my sides are equal, and I have two sets of parallel sides. What shape(s) can I be? _____

Name: ANSWER KEY

Quadrilateral Table

Place a check mark in the appropriate boxes to show which figures have which properties. Then answer the questions that follow.

PROPERTY OF FIGURE	TYPES OF POLYGONS						
	Quadrilateral	**Parallelogram**	**Rectangle**	**Rhombus**	**Square**	**Trapezoid**	**Kite**
Only one set of parallel sides						✓	
Two sets of parallel sides		✓	✓	✓	✓		
Two sides of equal length		✓	✓		✓		
Four sides of equal length				✓	✓		
Four angles of equal measure			✓		✓		
All four angles are right angles			✓		✓		
It may contain a right angle	✓		✓		✓	✓	✓

Is a square a rectangle? Yes How do you know this? Because it has 4 sides, 4 right angles, and 2 sets of parallel sides

I have four sides and two sets of equal sides, but not all four of my sides are equal, and I have two sets of parallel sides. What shape(s) can I be? quadrilateral, rectangle, or parallelogram

✱ SOL 5.15b

Prerequisite SOL

None

Lesson Summary

Students sort a set of triangles into pairs and discover the relationship between the figures that are similar or congruent. Students create similar and congruent figures on geoboards. (40 minutes)

Materials

Sets of "Similar and Congruent Triangle Sorting Pieces"
Geoboards
Rubber bands
"Applying the Lesson" worksheets
"Similar or Congruent?" worksheets

Vocabulary

congruent figures. Two figures that are exactly the same in shape and size.
similar figures. Two figures that are exactly the same in shape but not necessarily the same in size.

Warm-up

Copy the 12 "Similar and Congruent Triangle Sorting Pieces" onto card stock and cut them out, making enough sets of 12 pieces to give a complete set to each pair of students. Alternatively, have each pair of students cut out their own set. After distributing the sets, ask the partners to pair up the triangles that are related in some way, explaining that for each triangle, there is another that is like it in one way or another. Have students write down the triangle pairs they matched and an explanation of why they paired the triangles the way they did.

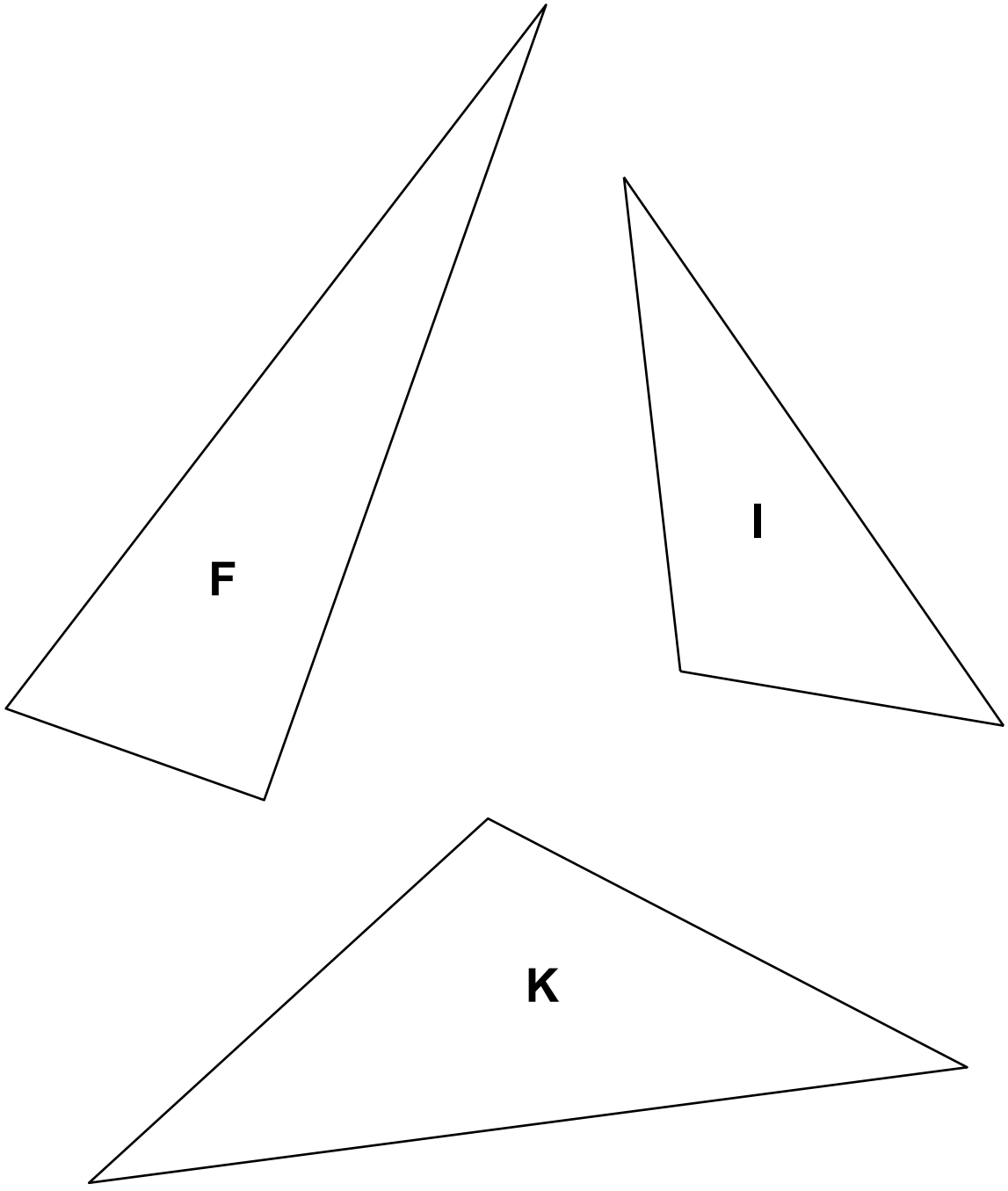
Lesson

1. Have student partners orally explain how they paired the triangles.
2. Talk about the triangles that are the same shape and same size. Give the students the definition of *congruent figures* (see above). Show example of congruent triangles.
3. Talk about the triangles that are the same shape but not the same size. Give the students the definition of *similar figures* (see above). Show example of similar triangles.
4. Pass out geoboards and rubber bands. Have students create similar and congruent figures according to your directions. For example, say, "Show me similar rectangles." Students should create two rectangles of the same shape but different size. Have students practice making these until they are familiar with the terms *similar* and *congruent*.
5. Have the students complete the "Applying the Lesson" worksheet, giving assistance as needed.

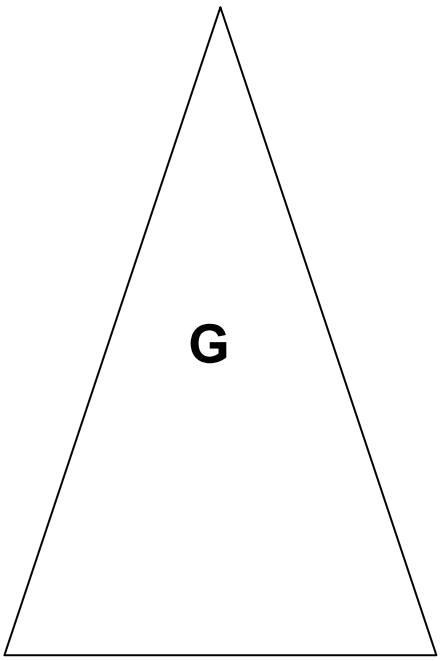
Reflection

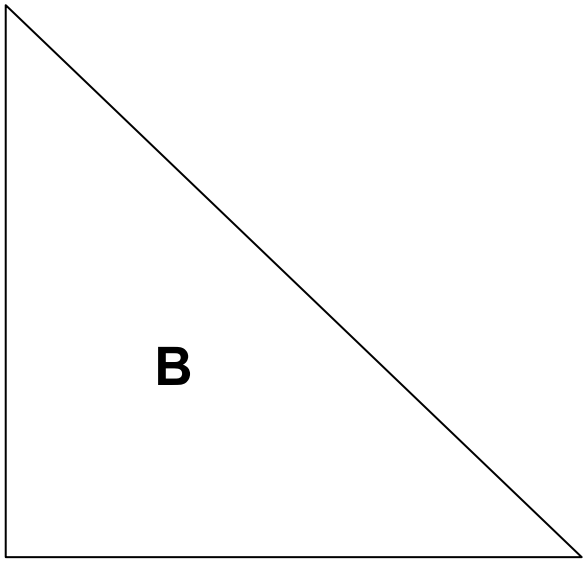
Have students complete the "Similar or Congruent?" worksheet.

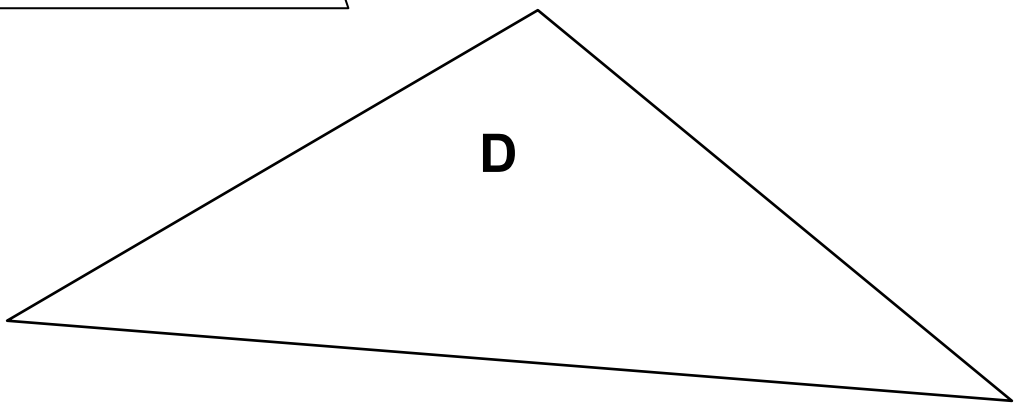
Similar and Congruent Triangle Sorting Pieces

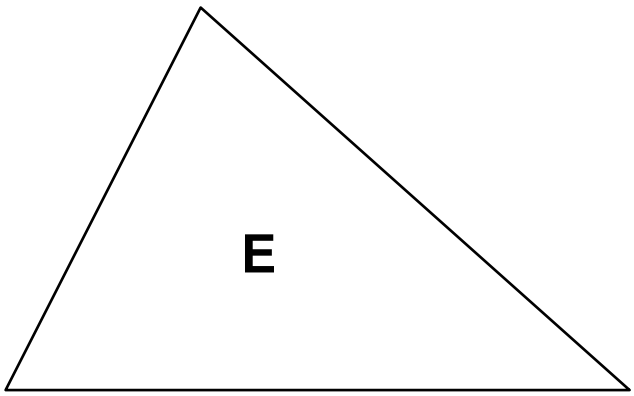


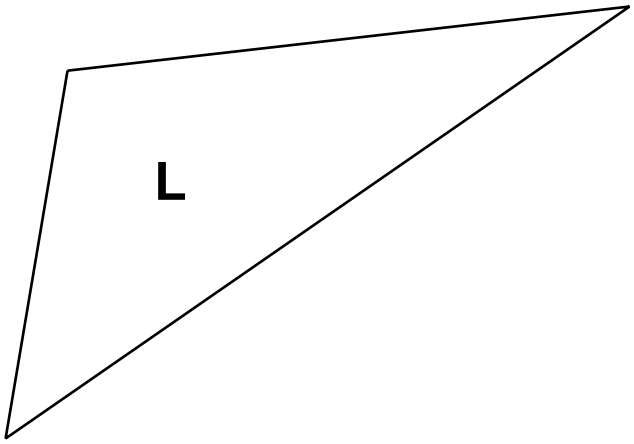
Similar and Congruent Triangle Sorting Pieces



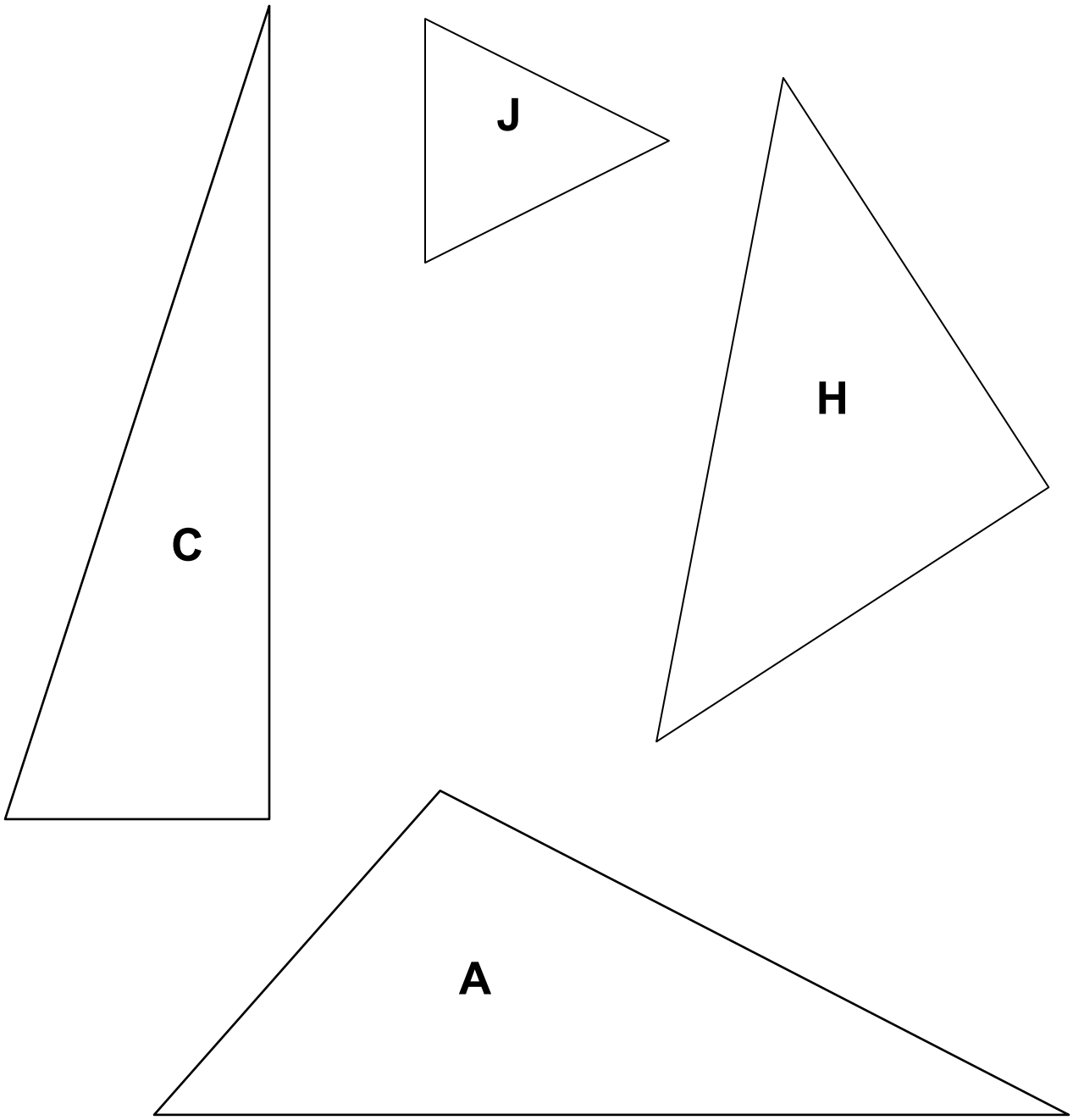








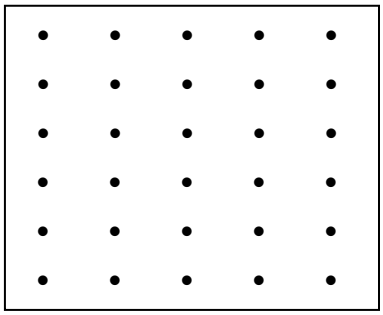
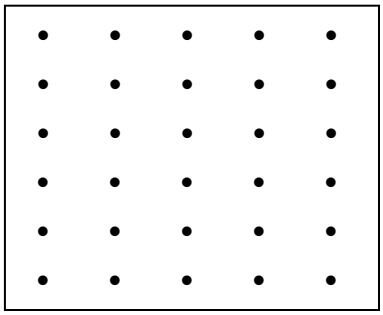
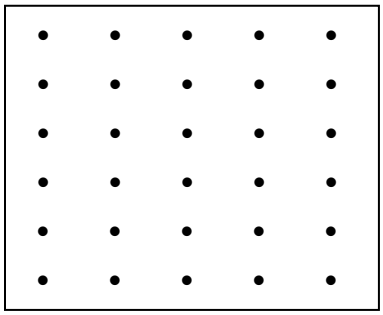
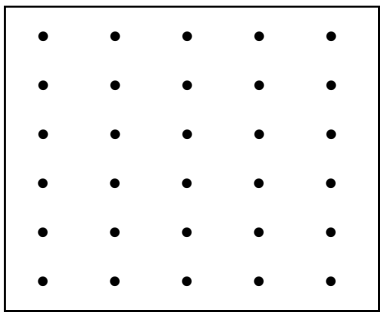
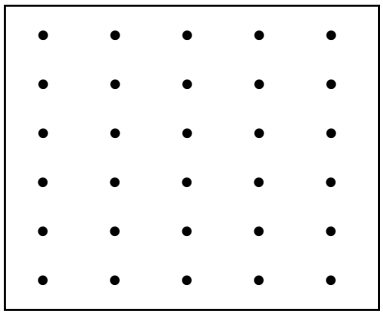
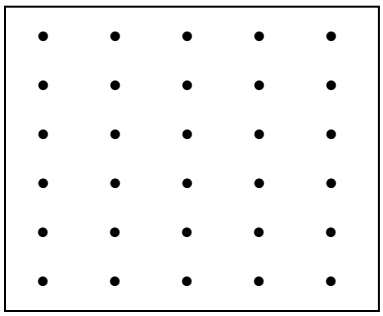
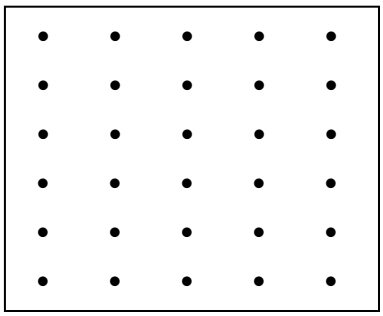
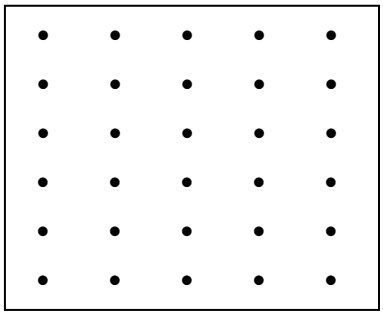
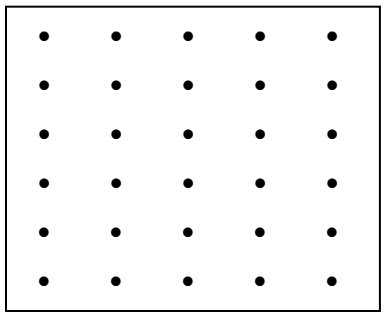
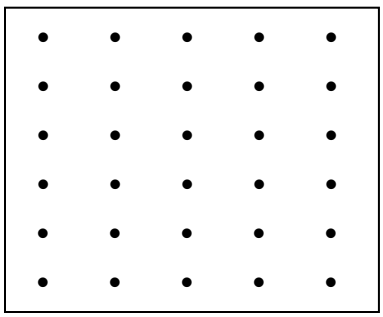
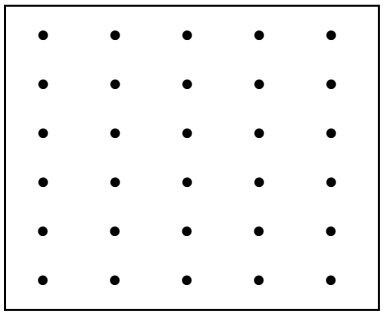
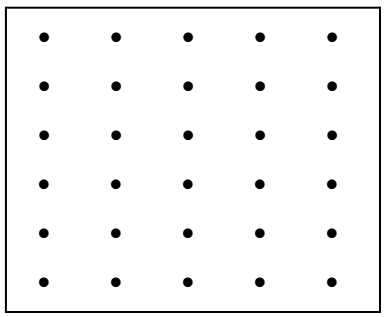
Similar and Congruent Triangle Sorting Pieces



Name: _____

Applying the Lesson

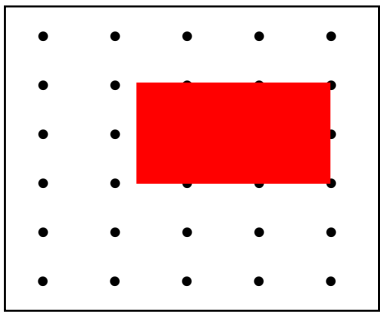
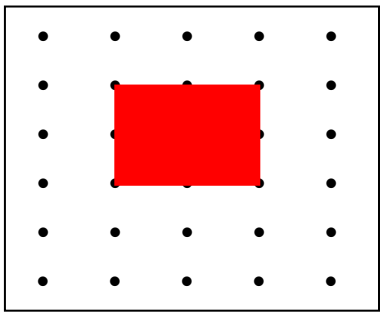
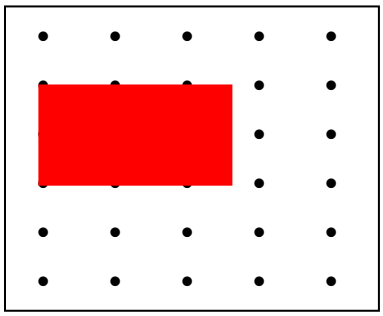
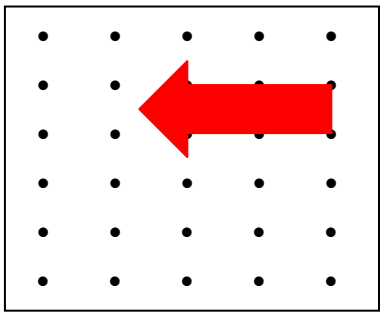
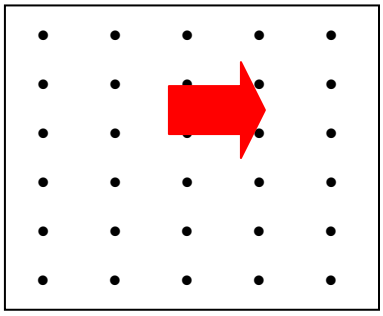
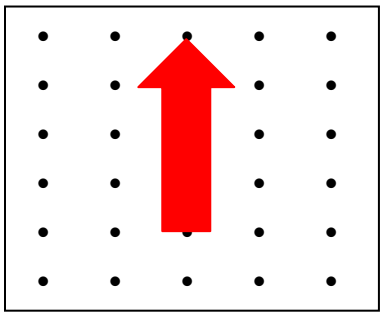
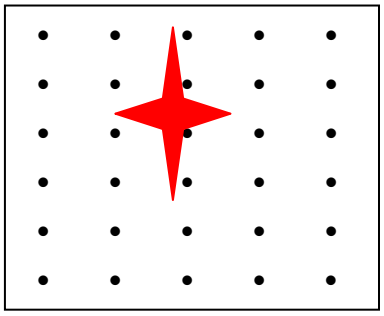
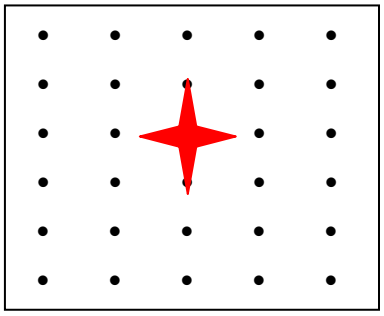
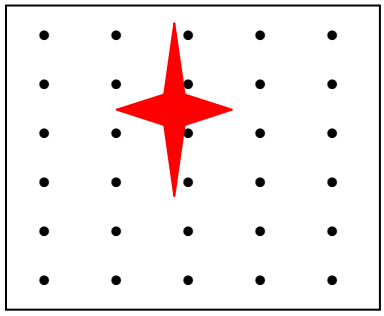
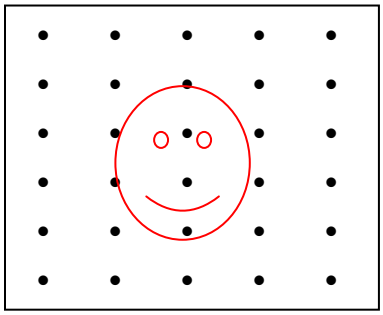
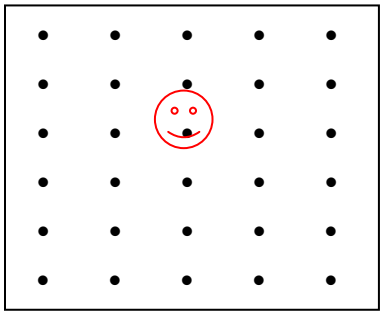
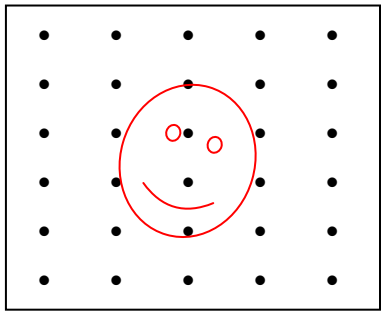
In the first box in each row, draw a simple figure. In the second box in that row, draw a figure similar to the original. In the third box, draw a figure congruent to the original figure.

Original Figure	**Similar Figure**	**Congruent Figure**
		
		
		
		

Name: ANSWER KEY

Applying the Lesson

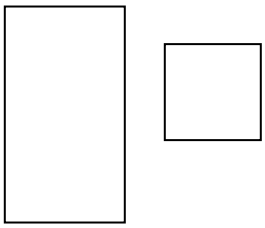
In the first box in each row, draw a simple figure. In the second box in that row, draw a figure similar to the original. In the third box, draw a figure congruent to the original figure.

Original Figure	Similar Figure	Congruent Figure
		
		
		
		

Name: _____

Similar or Congruent?

Label each pair of figures below as **similar, congruent,** or **neither**. Then, justify your answer with its mathematical definition.

1. 

These figures are _____ because

_____

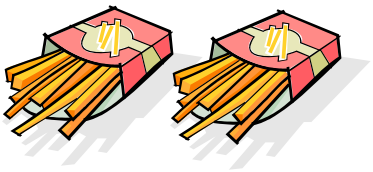
_____

2. 

These figures are _____ because

_____

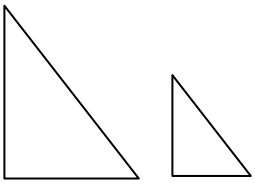
_____

3. 

These figures are _____ because

_____

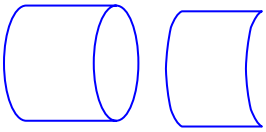
_____

4. 

These figures are _____ because

_____

_____

5. 

These figures are _____ because

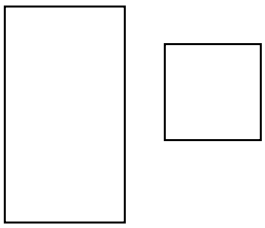
_____

_____

Name: ANSWER KEY

Similar or Congruent?

Label each pair of figures below as **similar, congruent,** or **neither**. Then, justify your answer with its mathematical definition.

1. 

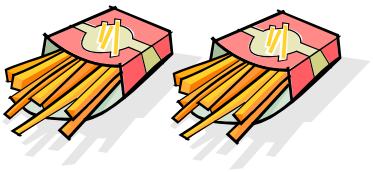
These figures are similar because

they are exactly the same in shape but different in size.

2. 

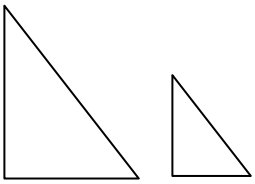
These figures are congruent because

they are exactly the same in shape and size.

3. 

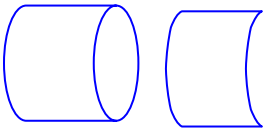
These figures are congruent because

they are exactly the same in shape and size.

4. 

These figures are similar because

they are exactly the same in shape but different in size.

5. 

These figures are neither because

they are neither the same shape nor the same size.

✱ SOL 6.15, 7.11

Prerequisite SOL

5.15

Lesson Summary

Students sort triangles and quadrilaterals and discover similar and congruent relationships among the figures. (30–40 minutes)

Materials

"Similar and Congruent Figures Concept Card"
Sets of "Similar and Congruent Sorting Pieces"
"Similar or Congruent Figures Chart"
"Similar or Congruent?" worksheets

Vocabulary

congruent figures. Two figures that are exactly the same in shape and size.
similar figures. Two figures that are exactly the same in shape but not necessarily the same in size.

Warm-up

Give each student a "Similar and Congruent Figures Concept Card." Based on the information given on the card, have students draw their own pairs of congruent, similar, noncongruent, and nonsimilar figures. Have students write their own definitions of these terms, based on their understanding of the words in context. When they are done, have them share their card with a partner. Bring the class together, and go over the students' responses.

Lesson

1. Copy the "Similar and Congruent Sorting Pieces" onto card stock and cut them out, making enough sets of pieces to give a complete set to each pair of students. After distributing the sets of sorting pieces and the "Similar or Congruent Figures Charts," ask the partners to sort the shapes into pairs according to whether they are similar or congruent. Instruct them to place (or write) the pairs on the correct side of the chart.
2. Have each group orally explain how they paired the figures.
3. Talk about the figures that are the same shape and same size. Review the definition of *congruent figures* (see above), stressing that all properties of the two figures are exactly the same and that the two figures would match perfectly if one were laid on top of the other. Show other examples of congruent figures.
4. Talk about the figures that are the same shape but not the same size. Review the definition of *similar figures* (see above). Ask students to compare two similar figures, noticing what is similar and what is different. They should observe that the angles are congruent but the sides are not. Show other examples of similar figures. Ask: "Are all congruent figures also similar figures?"
5. Have students go back and make any necessary changes to the definitions on their concept cards.

Reflection

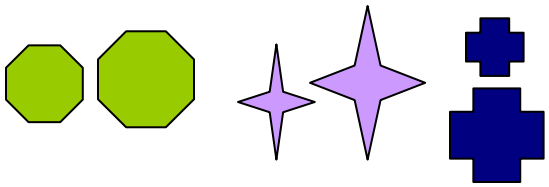
Have students complete the "Similar or Congruent?" worksheet.

Name: _____

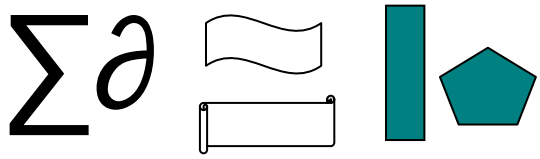
Similar and Congruent Figures Concept Card

Similar Figures

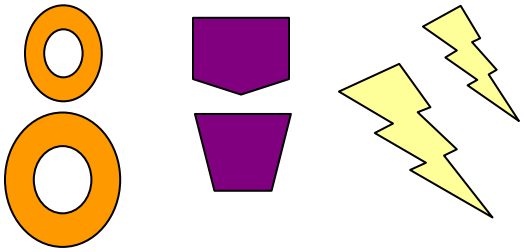
These pairs of figures are <u>similar</u>.



These pairs of figures are <u>nonsimilar</u>.



Which of these pairs of figures are similar?



Draw your own pair of similar figures.

Draw your own pair of nonsimilar figures.

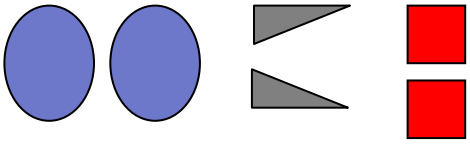
What are similar figures?

<u>Similar figures are</u> _____

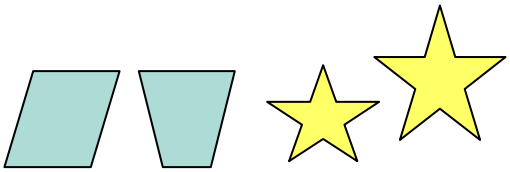
_____.

Congruent Figures

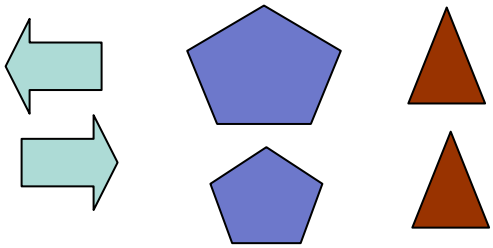
These pairs of figures are <u>congruent</u>.



These pairs of figures are <u>noncongruent</u>.



Which of these pairs of figures are congruent?



Draw your own pair of congruent figures.

Draw your own pair of noncongruent figures.

What are congruent figures?

<u>Congruent figures are</u> _____

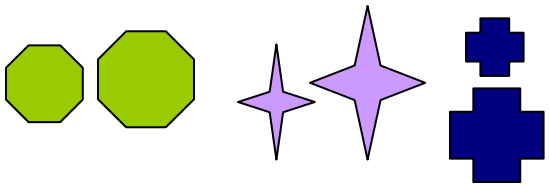
_____.

Name: ANSWER KEY

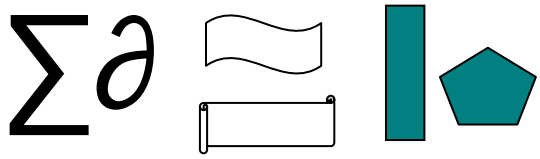
Similar and Congruent Figures Concept Card

Similar Figures

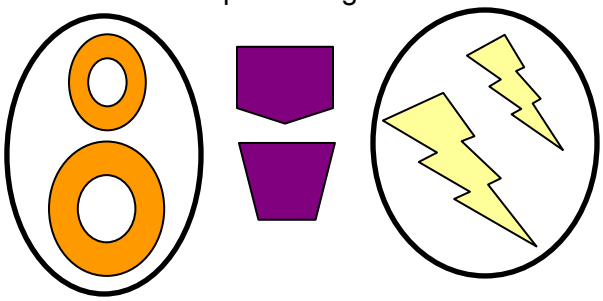
These pairs of figures are similar.



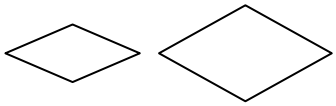
These pairs of figures are nonsimilar.



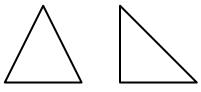
Which of these pairs of figures are similar?



Draw your own pair of similar figures.
Sample answer:



Draw your own pair of nonsimilar figures.
Sample answer:

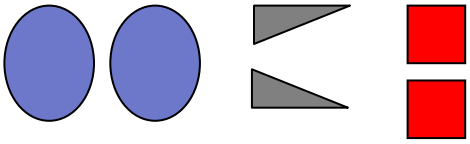


What are similar figures? Sample answer:

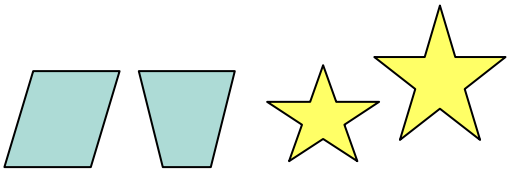
Similar figures are two figures that are exactly the same in shape but not necessarily the same in size.

Congruent Figures

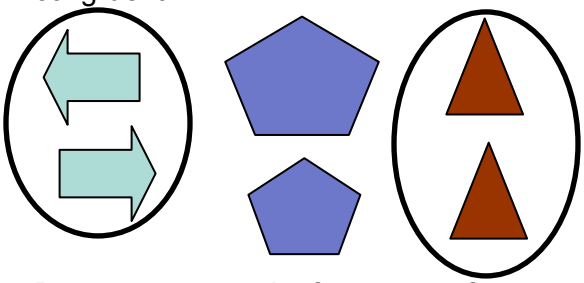
These pairs of figures are congruent.



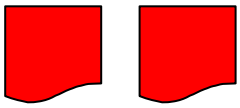
These pairs of figures are noncongruent.



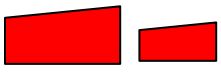
Which of these pairs of figures are congruent?



Draw your own pair of congruent figures.
Sample answer:



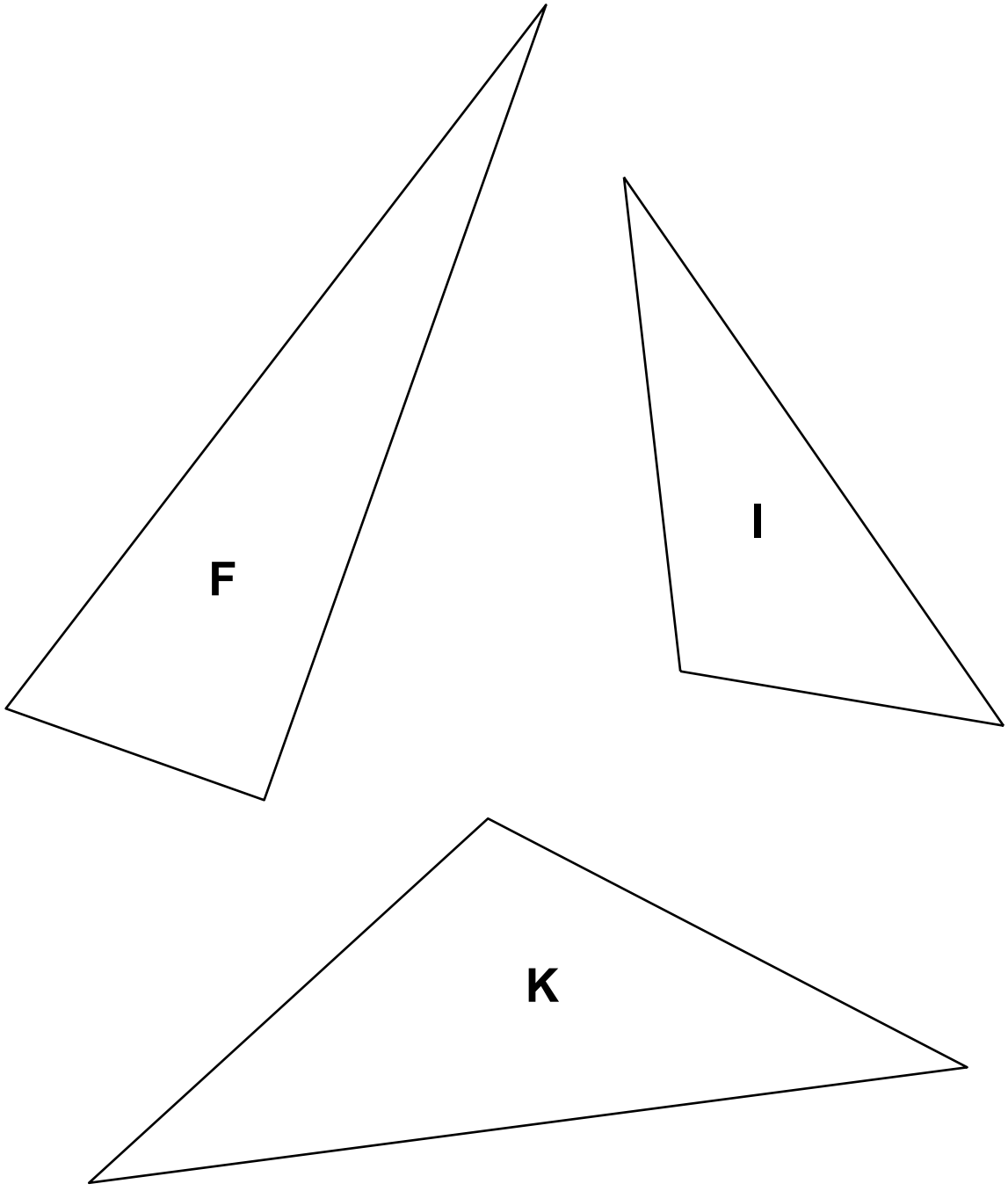
Draw your own pair of noncongruent figures.
Sample answer:



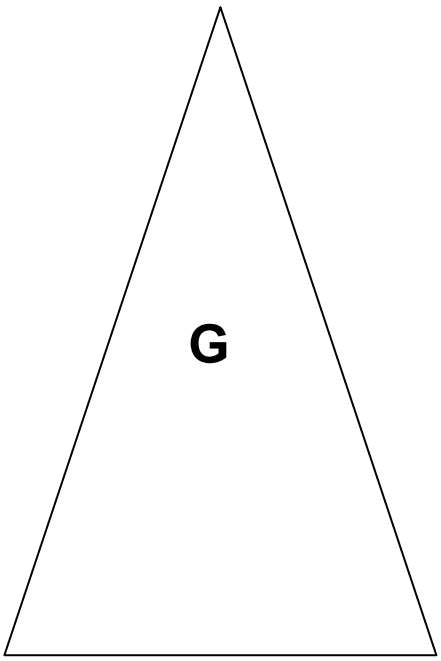
What are congruent figures? Sample answer:

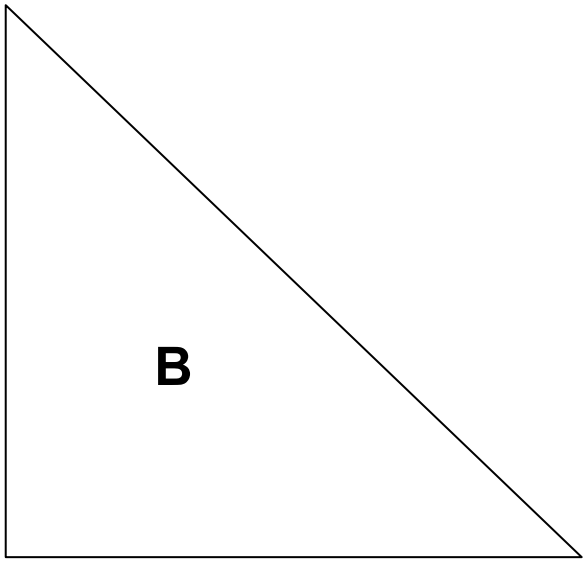
Congruent figures are two figures that are exactly same in shape and size.

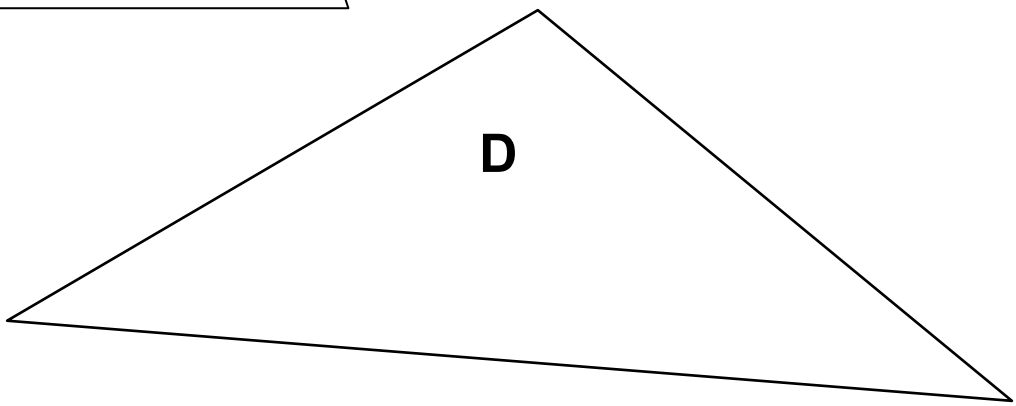
Similar and Congruent Figures Sorting Pieces

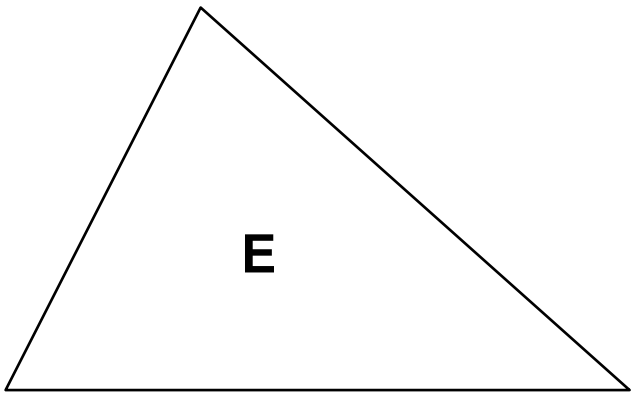


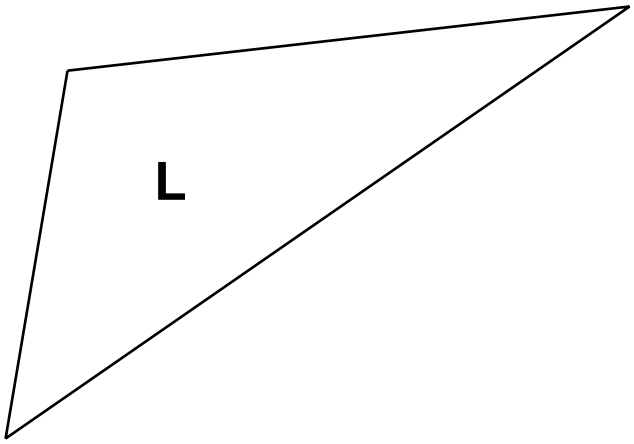
Similar and Congruent Figures Sorting Pieces



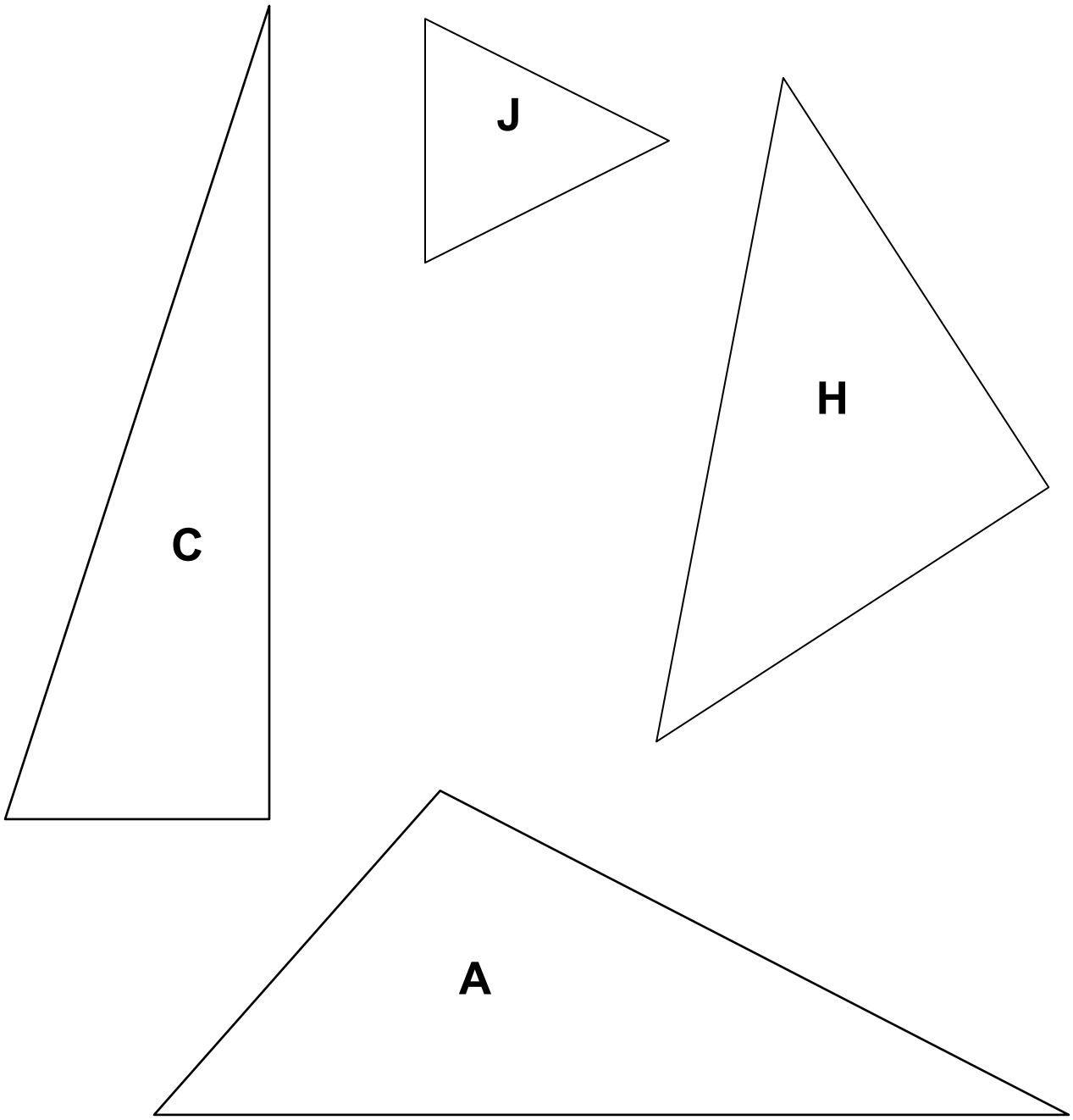




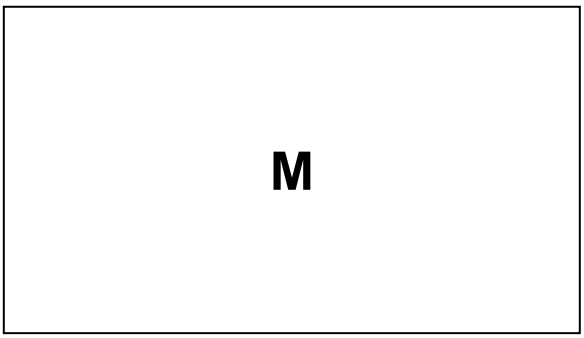


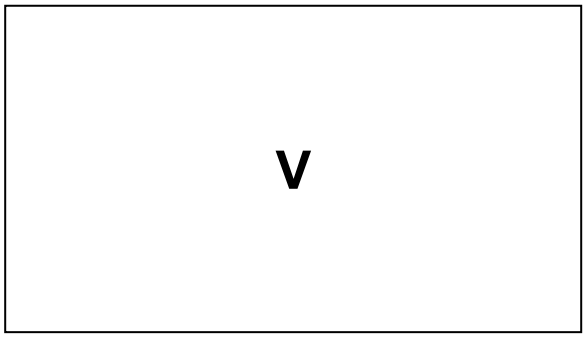


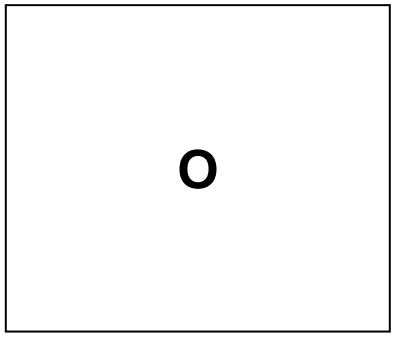
Similar and Congruent Figures Sorting Pieces

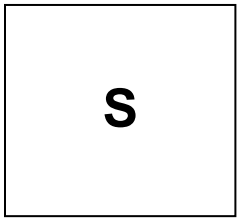


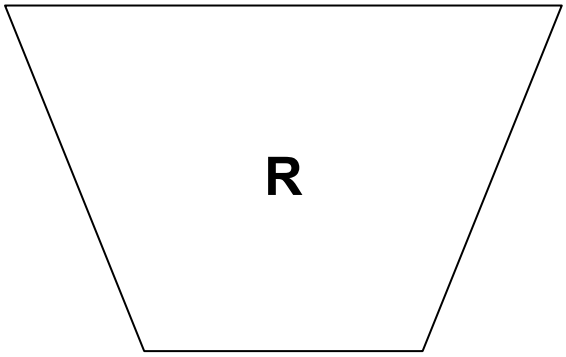
Similar and Congruent Figures Sorting Pieces

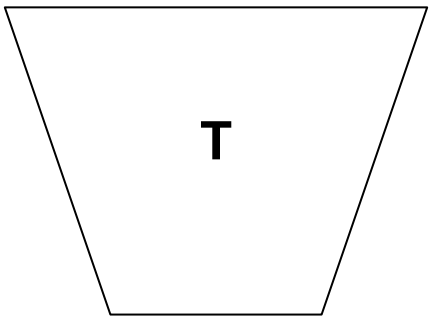




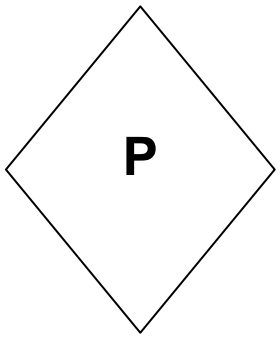


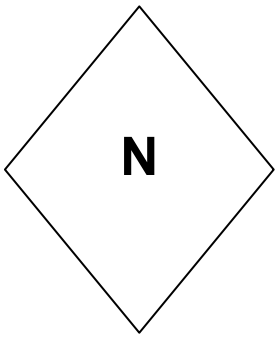


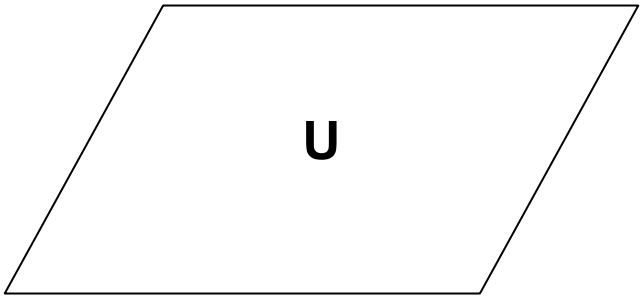


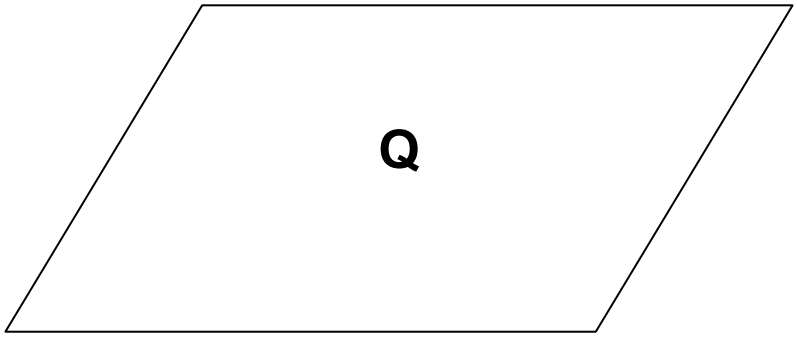


Similar and Congruent Figures Sorting Pieces









Name: _____

Similar or Congruent Figures Chart

Sort the figures into pairs according to whether they are similar or congruent. Then, identify the pairs by writing their letters in the chart below.

SIMILAR FIGURES	CONGRUENT FIGURES

Name: ANSWER KEY

Similar or Congruent Figures Chart

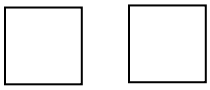
Sort the figures into pairs according to whether they are similar or congruent. Then, identify the pairs by writing their letters in the chart below.

SIMILAR FIGURES	CONGRUENT FIGURES
O & S	P & N
R & T	M & V
U & Q	C & F
J & G	H & B
A & E	I & L
	D & K

Name: _____

Similar or Congruent?

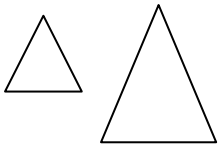
Determine whether each pair of figures below is **similar** or **congruent**, and give a brief explanation of your answer.

1. 

These figures are _____ because

_____

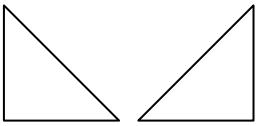
_____.

2. 

These figures are _____ because

_____

_____.

3. 

These figures are _____ because

_____

_____.

4. Draw a pair of quadrilaterals that are similar and another pair that are congruent. Label the pairs.

Answer *True* or *False* to the following questions. If false, explain why.

5. Congruent figures are always similar. _____

6. Similar figures are never congruent. _____

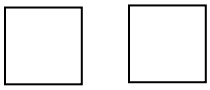
_____

_____

Name: ANSWER KEY

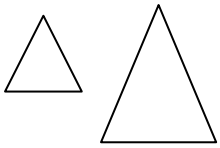
Similar or Congruent?

Determine whether each pair of figures below is **similar** or **congruent**, and give a brief explanation of your answer.

1. 

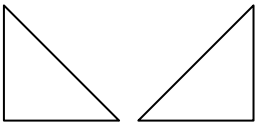
These figures are congruent because

they are exactly the same in shape and size.

2. 

These figures are similar because

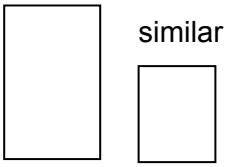
they are exactly the same in shape but different in size.

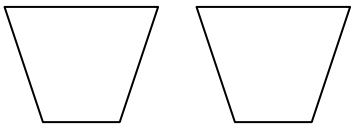
3. 

These figures are congruent because

they are exactly the same in shape and size.

4. Draw a pair of quadrilaterals that are similar and another pair that are congruent. Label the pairs. Sample answers:





Answer *True* or *False* to the following questions. If false, explain why.

5. Congruent figures are always similar. True

6. Similar figures are never congruent. False. They may be the same in size, and if they are, they are congruent.

✱ SOL 5.15b,e

Prerequisite SOL

None

Lesson Summary

Students identify and explore congruent and noncongruent figures. They investigate and recognize figures after they have been translated, rotated, or reflected. (40 minutes)

Materials

"Congruent Figures Concept Card"	"Congruent Figures" worksheets
Scrap paper	Patty paper or tracing paper
"Rectangle Templates" worksheets	"Reflecting on Congruent Figures" worksheets

Vocabulary

congruent figures. Two figures that are exactly the same in shape and size.
translation. A transformation in which a plane figure is moved (slid) to another location without any change in size or orientation.
reflection. A transformation in which a plane figure is reflected (flipped) across a line, creating a mirror image.
rotation. A transformation in which a plane figure is rotated (turned) around a fixed center point.

Warm-up

Give each student a "Congruent Figures Concept Card." Based on the information given on the card, have students draw their own examples of congruent and noncongruent figures. Have students write their own definitions of these terms, based on their understanding of the words in context. When they are done, have them share their card with a partner. Bring the class together, and go over the students' responses.

Lesson

1. Give each student a "Rectangle Templates" worksheet, and ask students to cut out one of the rectangles and use it as a template to draw a rectangle on a sheet of scrap paper. Then, ask them to draw another rectangle, using the same template, at another place on the same sheet but to turn the template a different way so that the two rectangles appear to be different. Next, ask them to use another smaller or larger rectangular template to draw a third rectangle on the sheet. Ask students to describe the three rectangles on the sheet. This discussion should lead to an understanding of the word *congruent*, meaning two figures that are exactly the same in shape and size, as well as the meaning of the word *noncongruent*, meaning two figures that are not the same in shape and/or size.
2. Based on the discussion for congruent figures, have students make necessary changes to their definitions and examples on their concept cards.
3. Ask students to trace the original rectangle template at the very top of another sheet of scrap paper. Then, ask them to trace another identical rectangle below it but to turn and flip the rectangle template so that it is difficult to tell whether the two rectangles really are congruent. Have students trace a few more identical rectangles in different positions and a few non-identical rectangles on the sheet. When they are done, have them trade papers.
4. After the papers have been traded, give students a minute to determine which rectangles are congruent to the one at the top of the paper. After they have decided, hand out the patty paper or tracing paper, and have them trace the original rectangle at the top. Then have them turn and/or flip their tracing to identify the rectangles that are congruent. Ask the students to circle the congruent rectangles.
5. Have students use the tracing method to prove which figures are congruent on the "Congruent Figures" worksheet.

6. Next, have students use the original rectangle template to trace a rectangle in the center of another sheet of paper and label the drawing “Original.”
7. Have them realign the template with the new drawing, carefully slide the template in any direction without changing its orientation, trace another rectangle, and label this second rectangle “Translation (Slide).”
8. Next, have them execute a translation in another direction from the original but then rotate the template on one point, trace it, and label this third rectangle “Rotation (Turn).”
9. Finally, have the students execute a translation in yet another direction from the original but then flip the template over, trace it, and label this fourth rectangle “Reflection (Flip).”
10. While these figures are being drawn, discuss the reasons for using these terms to label these rectangles.
11. After you have discussed the terms, have students go back to the “Congruent Figures” worksheet. For each figure that they said was congruent with the one at the left, have students label how the second figure was moved, using one of the three terms *translation, rotation,* or *reflection.*

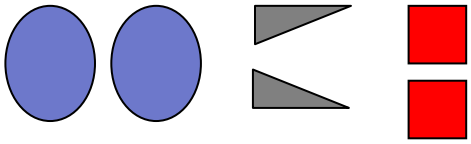
Reflection

Have students complete the “Reflecting on Congruent Figures” worksheet.

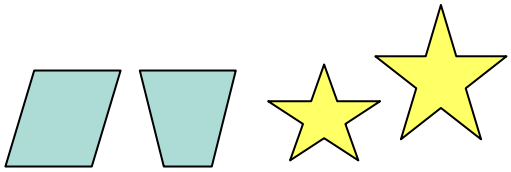
Name: _____

Congruent Figures Concept Card

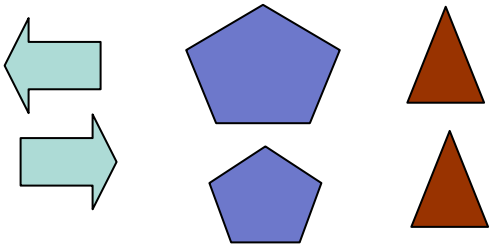
These pairs of figures are congruent.



These pairs of figures are noncongruent.



Which of these pairs of figures are congruent?



Draw your own pair of congruent figures.

Draw your own pair of noncongruent figures.

What are congruent figures?

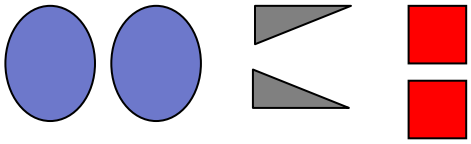
Congruent figures are _____

_____.

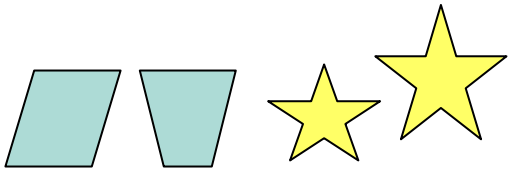
Name: ANSWER KEY

Congruent Figures Concept Card

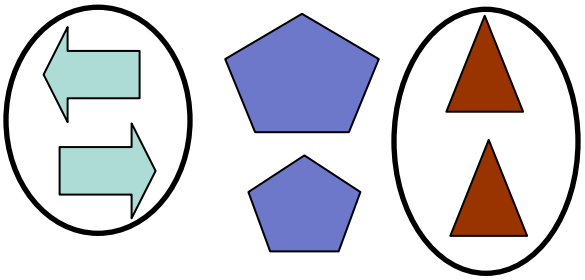
These pairs of figures are congruent.



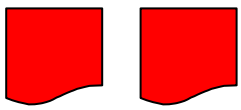
These pairs of figures are noncongruent.



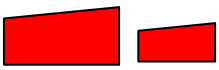
Which of these pairs of figures are congruent?



Draw your own pair of congruent figures.
Sample answer:



Draw your own pair of noncongruent figures.
Sample answer:

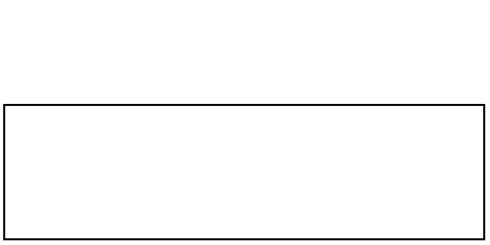


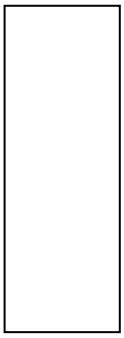
What are congruent figures? Sample answer:

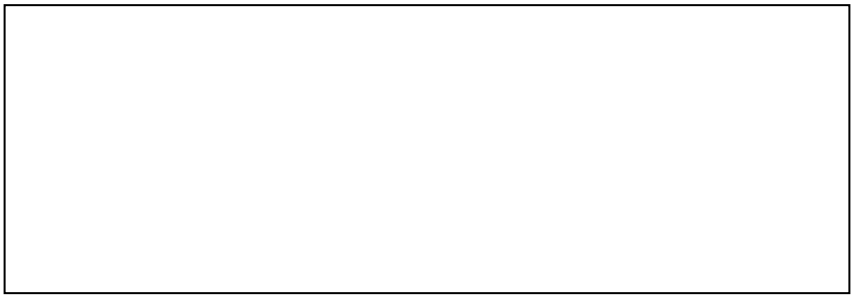
Congruent figures are two figures that are exactly the same in shape and size.

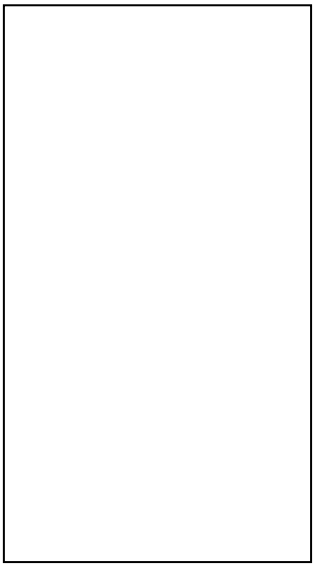
Name: _____

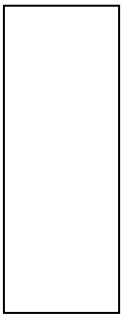
Rectangle Templates







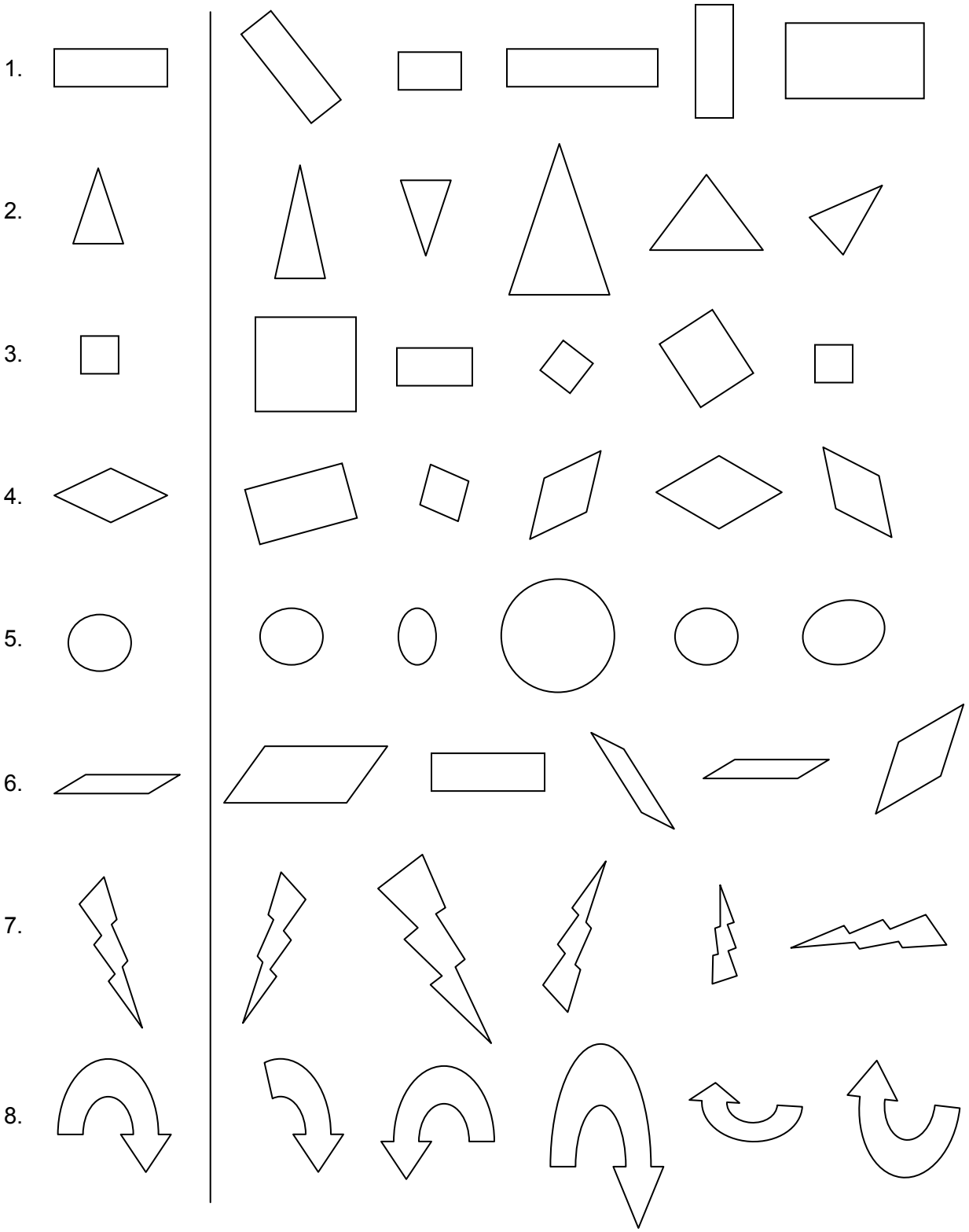




Name: _____

Congruent Figures Worksheet

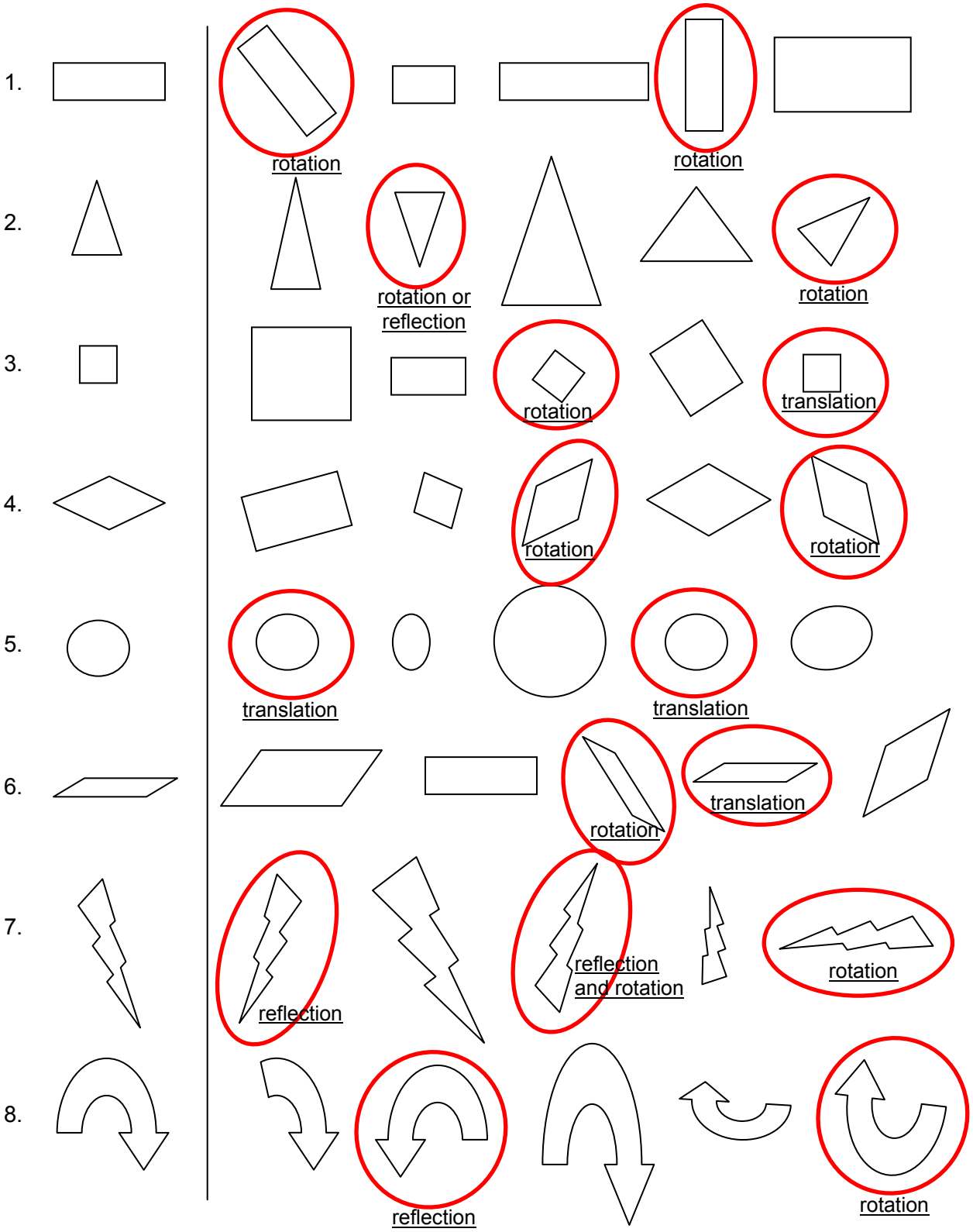
Look carefully each row of figures. Circle the figures in that row that are congruent to the first figure in the row, and label them “translation,” “rotation,” or “reflection.” Some figures might be labeled with two terms.



Name: ANSWER KEY

Congruent Figures Worksheet

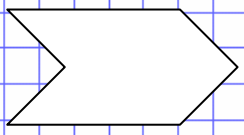
Look carefully each row of figures. Circle the figures in that row that are congruent to the first figure in the row, and label them “translation,” “rotation,” or “reflection.” Some figures might be labeled with two terms.

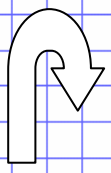


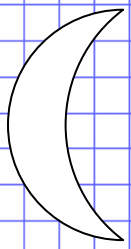
Name: _____

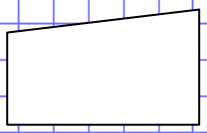
Reflecting on Congruent Figures

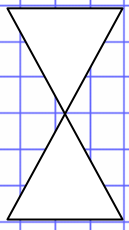
In the space below, draw a congruent figure for each figure shown.

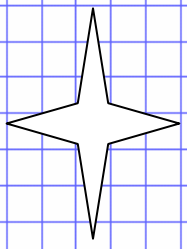
1. 

2. 

3. 

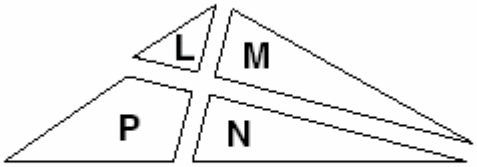
4. 

5. 

6. 

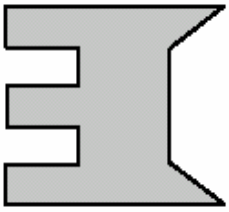
Reflecting on Congruent Figures

7. **Which 2 shapes below are congruent?**

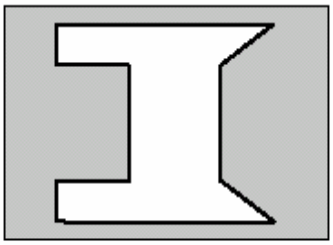


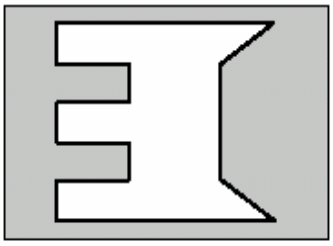
A L and P
B M and N
C N and L
D P and N

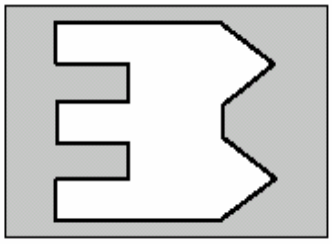
8. **Wayne cut this shape out of a piece of paper.**

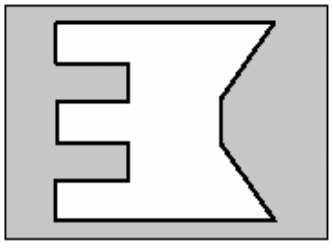


Which of the following is missing a piece exactly the same size and shape as the piece shown above?

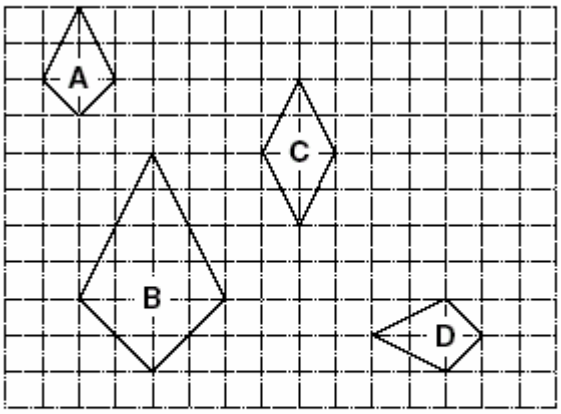
F 

G 

H 

J 

9. **Which figures appear to be congruent?**

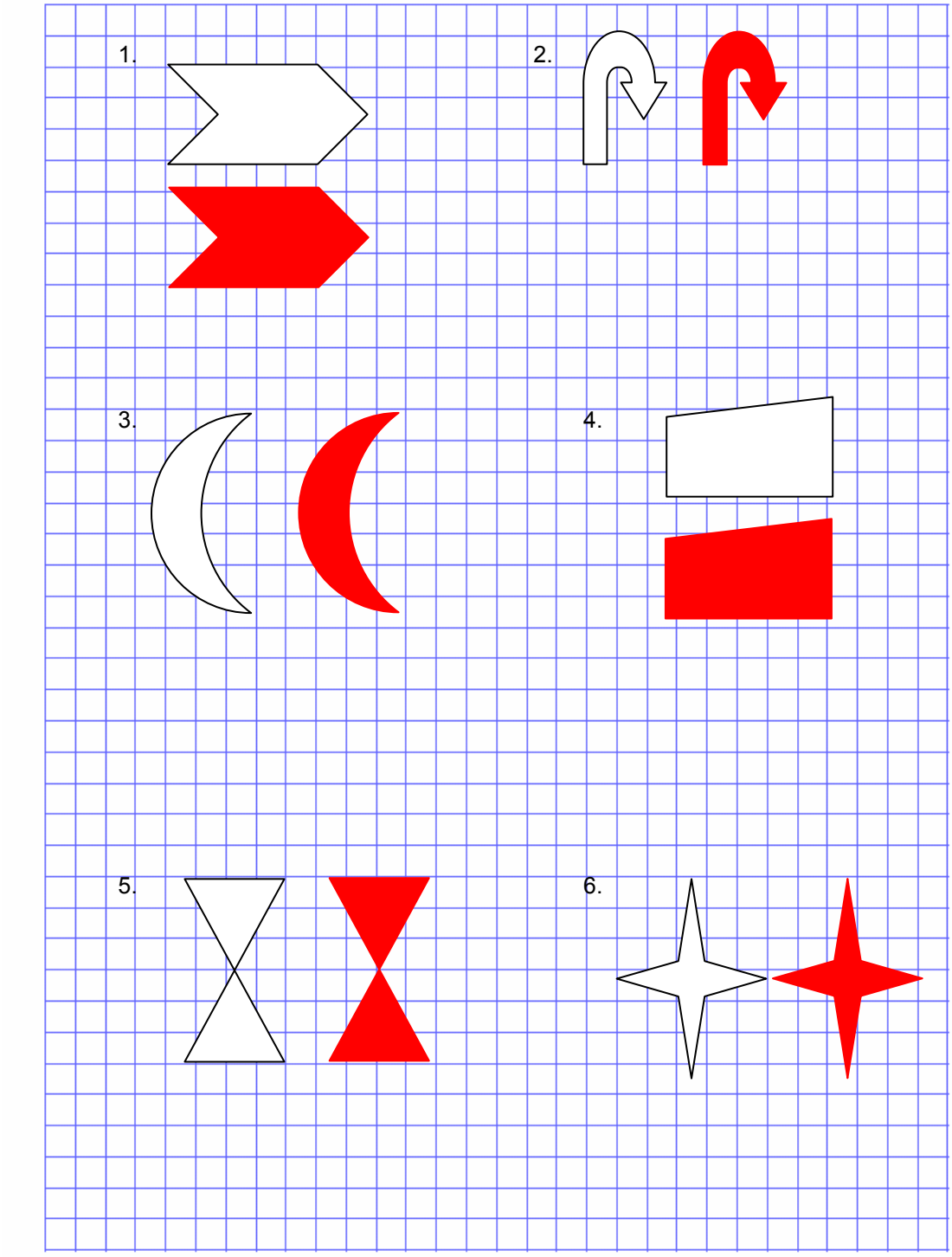


A A and B
B B and D
C C and D
D D and A

Name: ANSWER KEY

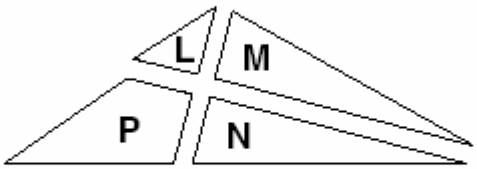
Reflecting on Congruent Figures

In the space below, draw a congruent figure for each figure shown.



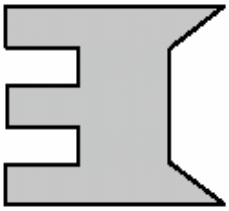
Reflecting on Congruent Figures

7. **Which 2 shapes below are congruent?**

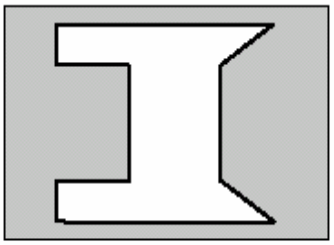


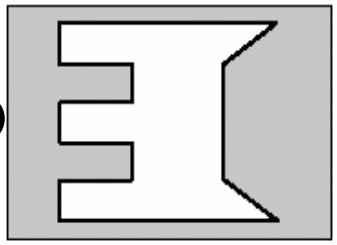
A L and P
B M and N
C N and L
D P and N

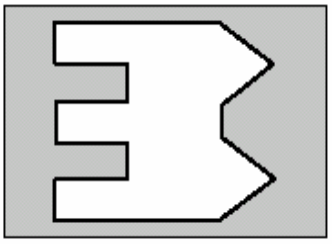
8. **Wayne cut this shape out of a piece of paper.**

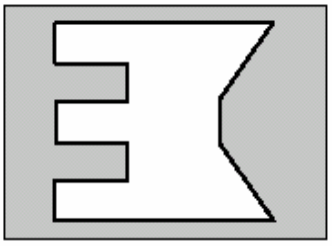


Which of the following is missing a piece exactly the same size and shape as the piece shown above?

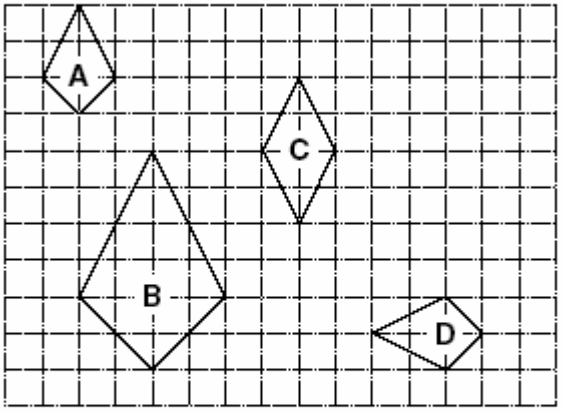
F 

G 

H 

J 

9. **Which figures appear to be congruent?**



A A and B
B B and D
C C and D
D D and A

✱ SOL 5.15c

Prerequisite SOL

5.15a

Lesson Summary

Students investigate and describe the results of combining and subdividing shapes, using tangram pieces. (30 minutes)

Materials

Sets of tangrams
"Tangrams Activity Chart"
"Tangram Puzzles" worksheets
"Assessment Questions" worksheets

Warm-up

Pass out the tangram pieces, or have the students cut them out from the "Tangram Template." Tell the students to write down the names of all seven pieces: A, B, C, D, E are right triangles, F is a square, and G is a parallelogram.

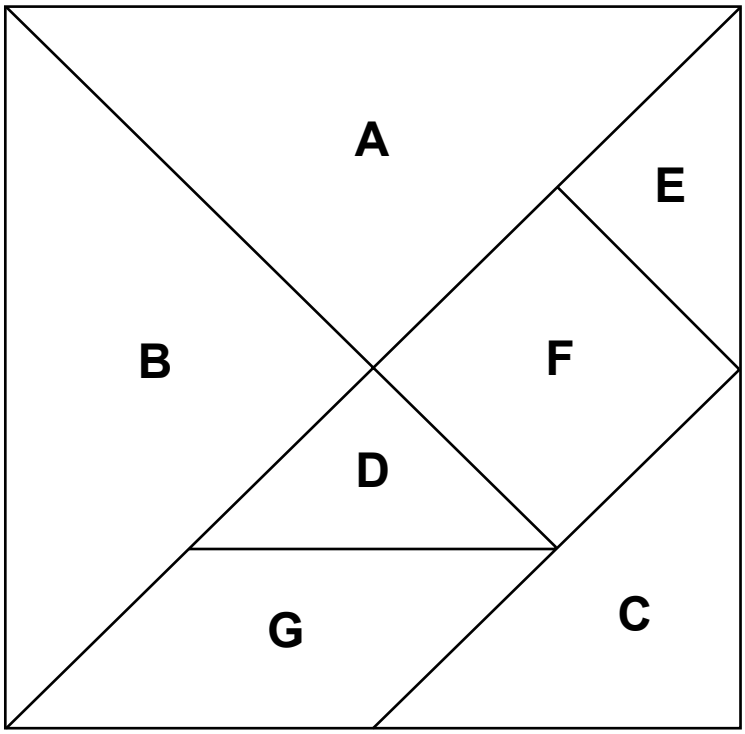
Lesson

1. Discuss with students the facts that two or more polygons can be combined to form a new shape and, conversely, that a polygon can be subdivided into two or more shapes.
2. Distribute the "Tangram Activity Chart". Have students follow the directions and then describe their solutions orally.
3. Pass out the Tangram Puzzle activity sheet. Have students make the figures using all seven tangram pieces and then draw a sketch of their solutions. Participants can work individually or in small groups to solve the tangram puzzles.

Reflection

Have students reflect on and write answers to the assessment questions.

Tangram Template



Name: _____

Tangram Activity Chart

Use the number of tangram pieces specified in the first column to form each of the geometric figures shown in the top row. As you make each shape, list in the proper box the pieces you use to make it. *Some problems may have more than one solution, while others may have no solution.*

Number of pieces	 Square	 Rectangle	 Triangle	 Trapezoid	 Parallel -ogram
2					
3					
4					
5					
6					
7					

Name: ANSWER KEY

Tangram Activity Chart

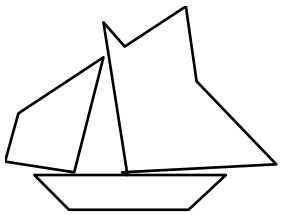
Use the number of tangram pieces specified in the first column to form each of the geometric figures shown in the top row. As you make each shape, list in the proper box the pieces you use to make it. *Some problems may have more than one solution, while others may have no solution.*
(Teacher's Note: For each problem with multiple solutions, only one is included here.)

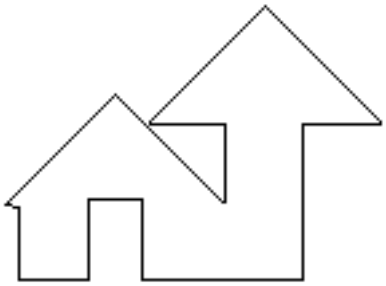
Number of pieces	 Square	 Rectangle	 Triangle	 Trapezoid	 Parallel -ogram
2	D & E	Not possible	D & E	D & F	D & E
3	D, E, & C	D, C, & E	D, E, & C	A, B, & C	D, E, & C
4	D, E, C, & B	D, E, C, & B	D, E, C, & B	D, E, A, & B	D, E, C, & B
5	D, E, F, G, & C	D, E, F, G, & C	D, E, F, G, & C	D, E, F, G, & C	D, E, F, G, & C
6	Not possible	C, E, F, D, G, & A	Not possible	C, E, F, D, G, & A	C, E, F, D, G, & A
7	All pieces	All pieces	All pieces	All pieces	All pieces

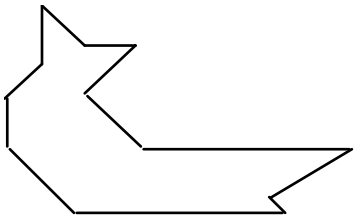
Name: _____

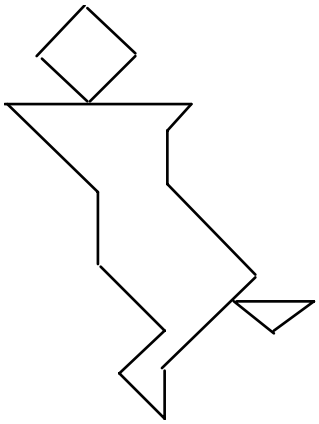
Tangram Puzzles

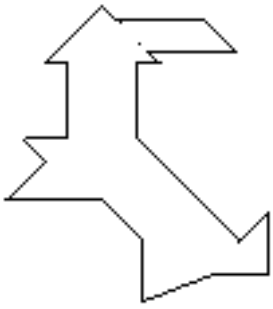
Can you make these figures, using all seven tangram pieces? Make a sketch of your solutions.

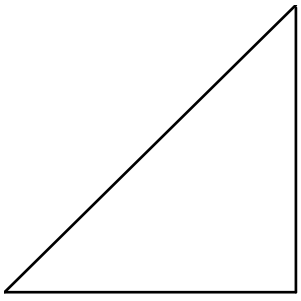
1. 

2. 

3. 

4. 

5. 

6. 

Name: _____

Assessment Questions

1. What strategy did you use to find the shapes?

2. Is there a basic shape that could be used to make all the figures?

3. Which pieces did you tend to use more than others? Why?

4. What are some other ways to construct each of the shapes?

5. Why is there no six-piece square?

✱ SOL 5.15e

Prerequisite SOL

None

Lesson Summary

Students define and recognize transformations as movement of geometric figures through a translation (slide), reflection (flip), or rotation (turn). (40 minutes)

Materials

Overhead geoboard and student geoboards
"Transformation Definitions Chart"
"Translation, Reflection, Rotation" worksheets
Patty paper or tracing paper
"Move Those Shapes!" activity sheets
"Reflecting on Transformations" worksheets
Music

Vocabulary

translation. A transformation in which a plane figure is moved (slid) to another location without any change in size or orientation.
reflection. A transformation in which a plane figure is reflected (flipped) across a line, creating a mirror image.
rotation. A transformation in which a plane figure is rotated (turned) around a fixed center point.
pre-image. An original figure.
image. A translated figure.

Warm-up

Begin by asking students to act out the motion of going down a roller coaster. Ask them whether they still look the same when they reach the bottom. (Their shape and orientation have not changed, but their location has changed.) Now, tell them to pretend they are making lunch, flipping hamburgers. Ask them what has changed for the flipped hamburger. (The shape has not changed, but the orientation has changed: it's been reversed, as a mirror image). Next, tell students to pretend they are playing basketball and their coach tells them to pivot. Ask them what has changed. (This move is simply a turn. Their shape has not changed, but their orientation has changed.) Emphasize that the shape of objects does not change when the objects are slid from place to place, flipped over, or turned around in place. Explain that there are three types of mathematical movements or transformations: translation (slide), reflection (flip), and rotation (turn).

Lesson

1. Demonstrate a **translation** on the overhead geoboard. Explain that a translation is a transformation in which an image is formed by moving every point on a pre-image the same distance in the same direction. Instruct students to demonstrate a translation on their geoboard.
2. Demonstrate a **reflection** on the overhead geoboard, and discuss how a reflection shows a "mirror image." Explain that a reflection is a transformation in which corresponding points in the image and pre-image are equidistant from the line of reflection. Instruct students to demonstrate a reflection on their geoboard.
3. Demonstrate a **rotation** on the overhead geoboard. Explain that a rotation is a transformation in which an image is formed by rotating or turning its pre-image around a fixed center point. Instruct students to demonstrate a rotation on their geoboard.
4. Explain to students that each of these focus words indicates a specific movement. Play some music, and ask everyone to stand up and slide to the right with you, and then to slide to the left. Then, ask them to put their hands out in front of them and flip their hands repeatedly. Then, ask them to make quarter turns clockwise or counterclockwise. Have students practice slide steps, hand flips, and quarter turns to the beat of the music. Using the words *slide, flip,* and *turn,* call out various transformations for the students to demonstrate and gauge their understanding of these basic terms.

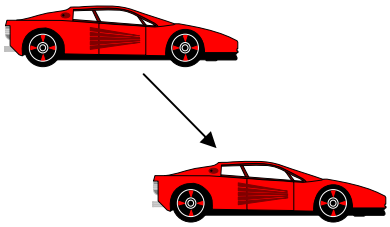
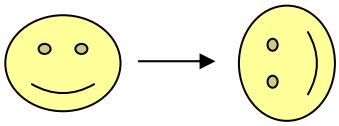
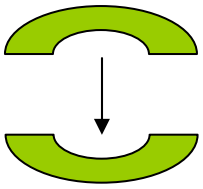
Then, substitute the words *translate, reflect,* and *rotate* in your chant. (Note: If some students are strongly opposed to participating in this part of the activity, you may choose to have just a few volunteers demonstrate it. A few may even want to create a "transformation" dance.)

5. Give each student a "Transformation Definitions Chart" illustrating the same types of movements with geometric figures. Connect the actual movements to the geometric movements through discussion.
6. Have students complete the "Translation, Reflection, Rotation" worksheets. If necessary, demonstrate how to use patty paper or tracing paper to copy one of the shapes and perform the transformations.
7. Pair up the students, and have them complete the "Move Those Shapes" activity by following the directions on the sheet.

Reflection

Have students complete the "Reflecting on Transformations" worksheet.

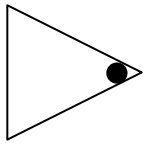
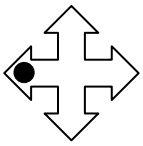
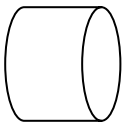
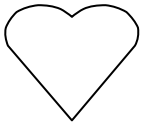
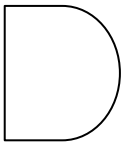
Transformation Definitions Chart

Translation (slide)	**Rotation (turn)**	**Reflection (flip)**
		
A transformation in which an image is formed by moving every point on a figure the same distance in the same direction.	A transformation in which an image is formed by turning its pre-image around a fixed point.	A transformation in which a figure is flipped over a line, called the line of reflection. All corresponding points in the image and pre-image are equidistant from the line of reflection.

Name: _____

Translation, Reflection, Rotation

Trace each original figure. Use the tracing to perform a translation, reflection, and rotation, and draw the result of each in the appropriate box.

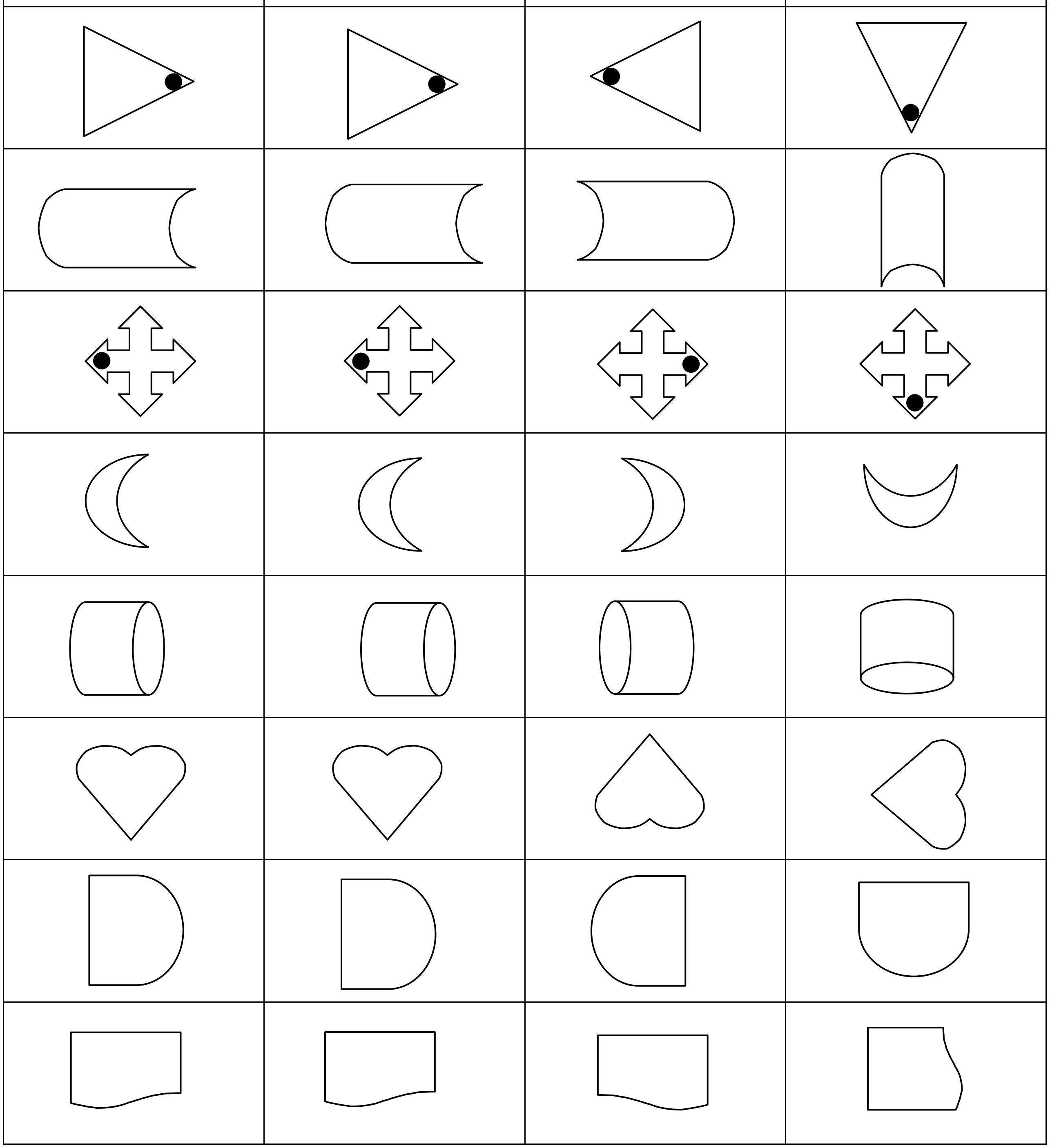
Original Figure	Translation	Reflection	Rotation
			
			
			
			
			
			
			
			

Name: <u>ANSWER KEY</u>

Translation, Reflection, Rotation

Trace each original figure. Use the tracing to perform a translation, reflection, and rotation, and draw the result of each in the appropriate box.
<u>Sample answers:</u>

Original Figure	**Translation**	**Reflection**	**Rotation**

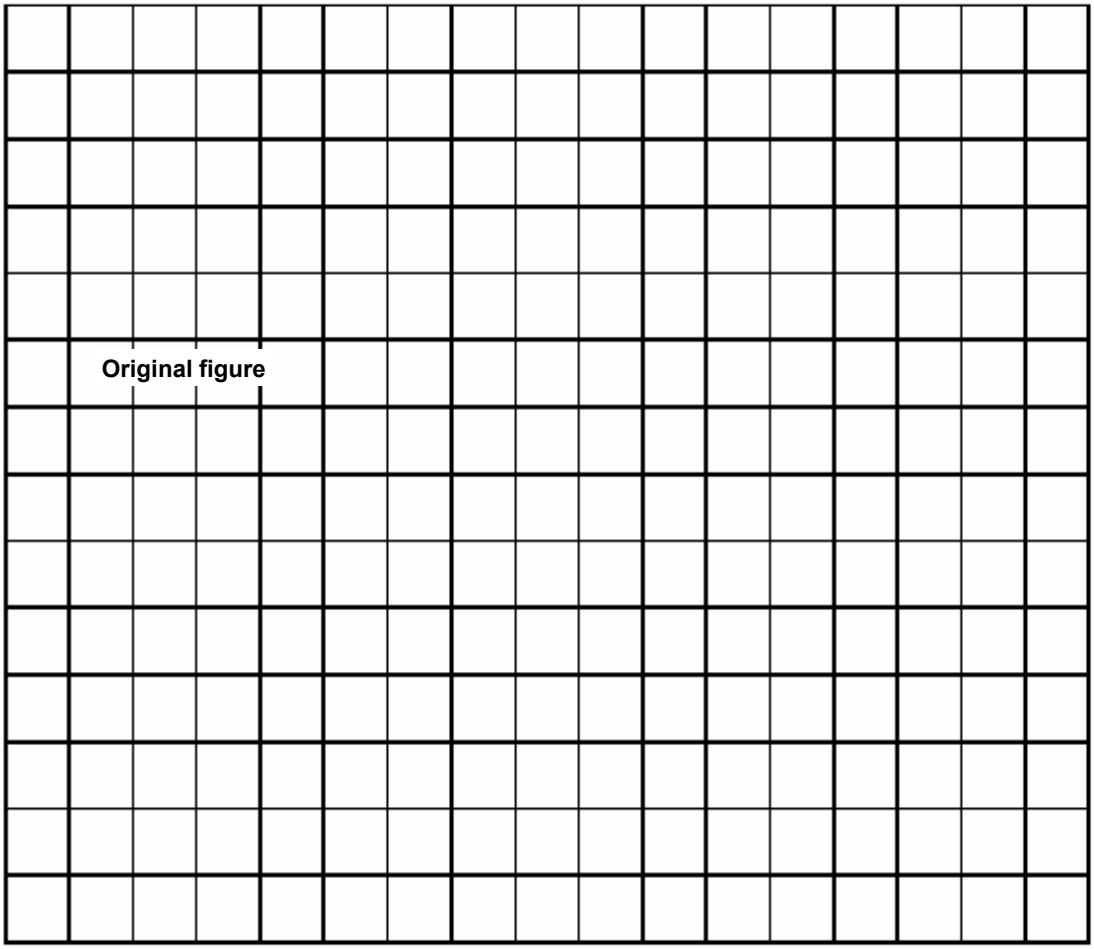


Name: _____

Move Those Shapes!

Draw all three transformations discussed in this lesson: **translation, reflection,** and **rotation.** Draw a figure in the top left portion of the grid paper. The figure should be different from all the others used in this lesson. Perform the first transformation on the original figure, and label the new figure "Figure B." Perform the second transformation on Figure B, and label the new figure "Figure C." Perform the final transformation on Figure C, and label the new figure "Figure D." Draw arrows to show the direction of each transformation.

Transformations: Fig. B. _____ Fig. C. _____ Fig. D. _____

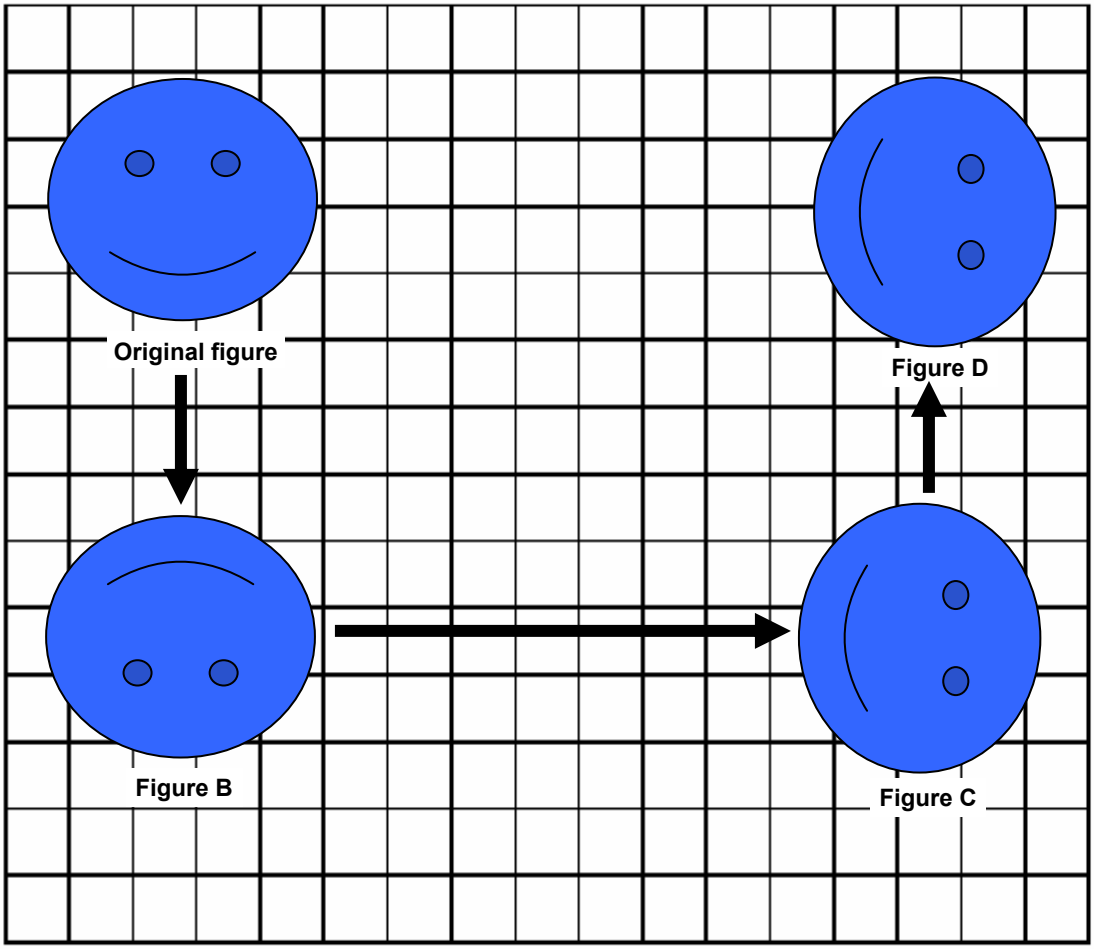


Name: ANSWER KEY

Move Those Shapes!

Draw all three transformations discussed in this lesson: **translation, reflection,** and **rotation.** Draw a figure in the top left portion of the grid paper. The figure should be different from all the others used in this lesson. Perform the first transformation on the original figure, and label the new figure "Figure B." Perform the second transformation on Figure B, and label the new figure "Figure C." Perform the final transformation on Figure C, and label the new figure "Figure D." Draw arrows to show the direction of each transformation.

Transformations: Fig. B. reflection Fig. C. rotation Fig. D. translation

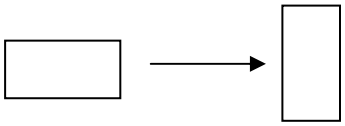


Name: _____

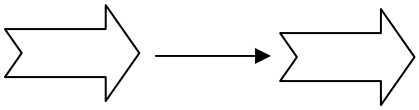
Reflecting on Transformations

For each change in position of the figures below, determine the type of transformation it is, and write the name of the transformation on the line provided.

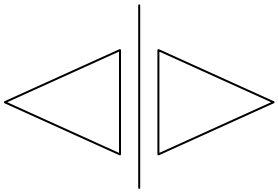
1. The example below is an illustration of a _____.



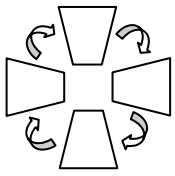
2. The example below is an illustration of a _____.



3. The example below is an illustration of a _____.



4. The example below is an illustration of a _____.



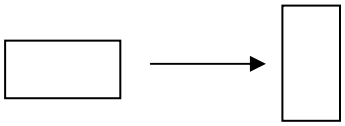
5. Write directions about how to go from your bedroom to your kitchen, using the verbs *translate, reflect,* and *rotate.*

Name: ANSWER KEY

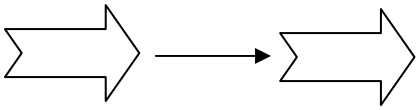
Reflecting on Transformations

For each change in position of the figures below, determine the type of transformation it is, and write the name of the transformation on the line provided.

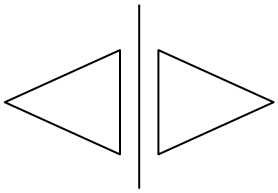
1. The example below is an illustration of a rotation.



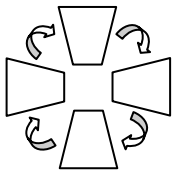
2. The example below is an illustration of a translation.



3. The example below is an illustration of a reflection.



4. The example below is an illustration of a rotation.



5. Write directions of how to go from your bedroom to your kitchen, using translations, reflections, and rotations.

   Sample Answer:

   Rotate to the right out my door, translate past two doors, rotate to the left, translate down the stairs, and reflect into the kitchen.

✱ SOL 5.15c,d

Prerequisite SOL

None

Lesson Summary

Students cut out polygon shapes and fold them to test for lines of symmetry. They then draw the corresponding lines of symmetry on dot paper. (40 minutes)

Materials

"Symmetry Warm-up" worksheets
"Symmetry Dot Paper Activity" worksheets
Dot paper (attached)
"Alphabet Symmetry" worksheets
"Symmetric Reflection" worksheets

Vocabulary

line of symmetry. A center line such that when a figure is folded on that line, both parts of the figure are congruent.

Warm-up

Have students complete the "Symmetry Warm-up" worksheet. After they have finished, have them discuss what they did with the shape to divide it in half. Ask: "Is there a relationship between the two pieces?" (They are congruent.)

Lesson

1. Have the students cut out the squares from the "Symmetry Dot Paper Activity" sheet.
2. Tell the students to fold the square in half so that the two sides fit exactly. Then, have them unfold the square and notice the crease or line created by the fold. Explain that this crease is called the "line of symmetry" and that a line of symmetry divides a figure into congruent halves, each of which is the reflected image of the other. Ask the students whether they can fold the square a different way so that the two parts fit exactly. Assist as needed. Continue until all lines of symmetry have been discovered.
3. Have the students trace the square on the dot paper provided and then draw the lines of symmetry on the square, using the creases they made as a guide.
4. Have students continue with the other figures, cutting them out, folding, tracing, and drawing.
5. Explain to the students that many letters of the alphabet have symmetry. Go over some examples of capital letters that have symmetry, e.g., A, B, C. Have students complete the "Alphabet Symmetry" worksheet.

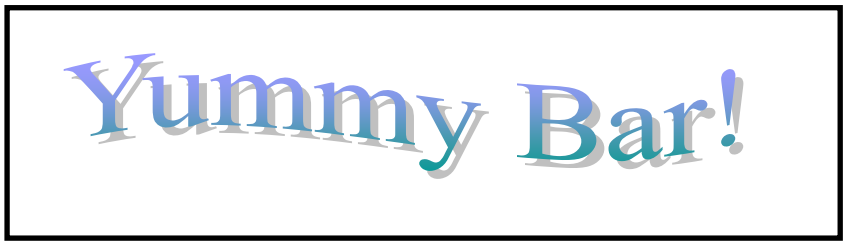
Reflection

Have students complete the **"**Symmetry Reflection" worksheet.

Name: _____

Symmetry Warm-up

Find all ways you can divide this rectangular candy bar in half or into two equal parts with a line. Ignore the words.



Write five things you discovered about dividing the shape in half.

1.

2.

3.

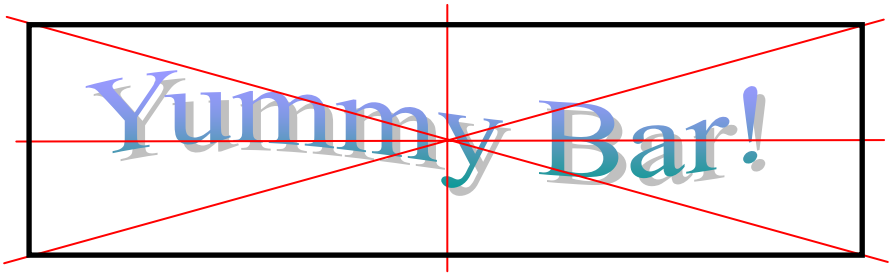
4.

5.

Name: ANSWER KEY

Symmetry Warm-up

Find all ways you can divide this rectangular candy bar in half or into two equal parts with a line. Ignore the words.



Write five things you discovered about dividing the shape in half.

Sample answers:

1. Formed 2 large rectangles.

2. Created two triangles.

3. Created a diagonal.

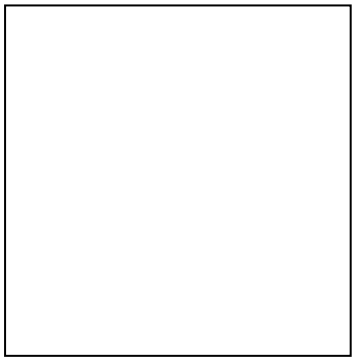
4. Made two equal parts.

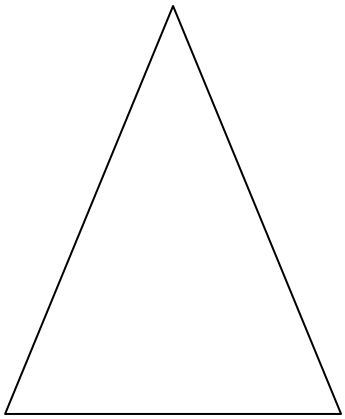
5. Formed 2 thin rectangles.

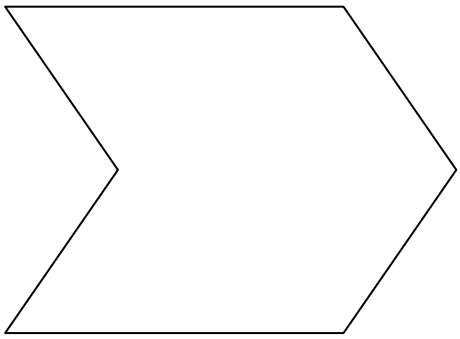
Name: _____

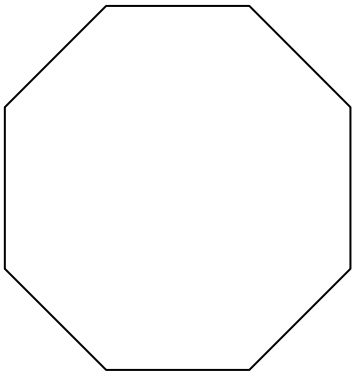
Symmetry Dot Paper Activity

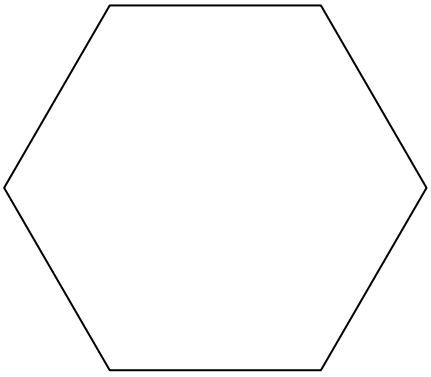
Cut out the shapes below. Fold each shape evenly to find all the lines of symmetry. Then draw your figures and their lines of symmetry on dot paper.

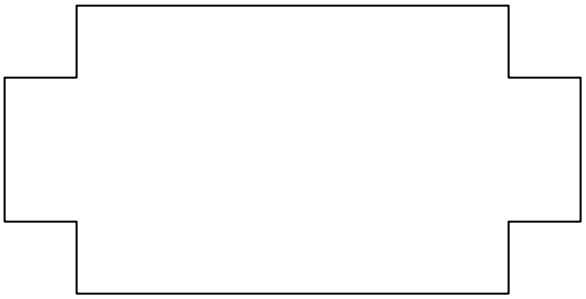




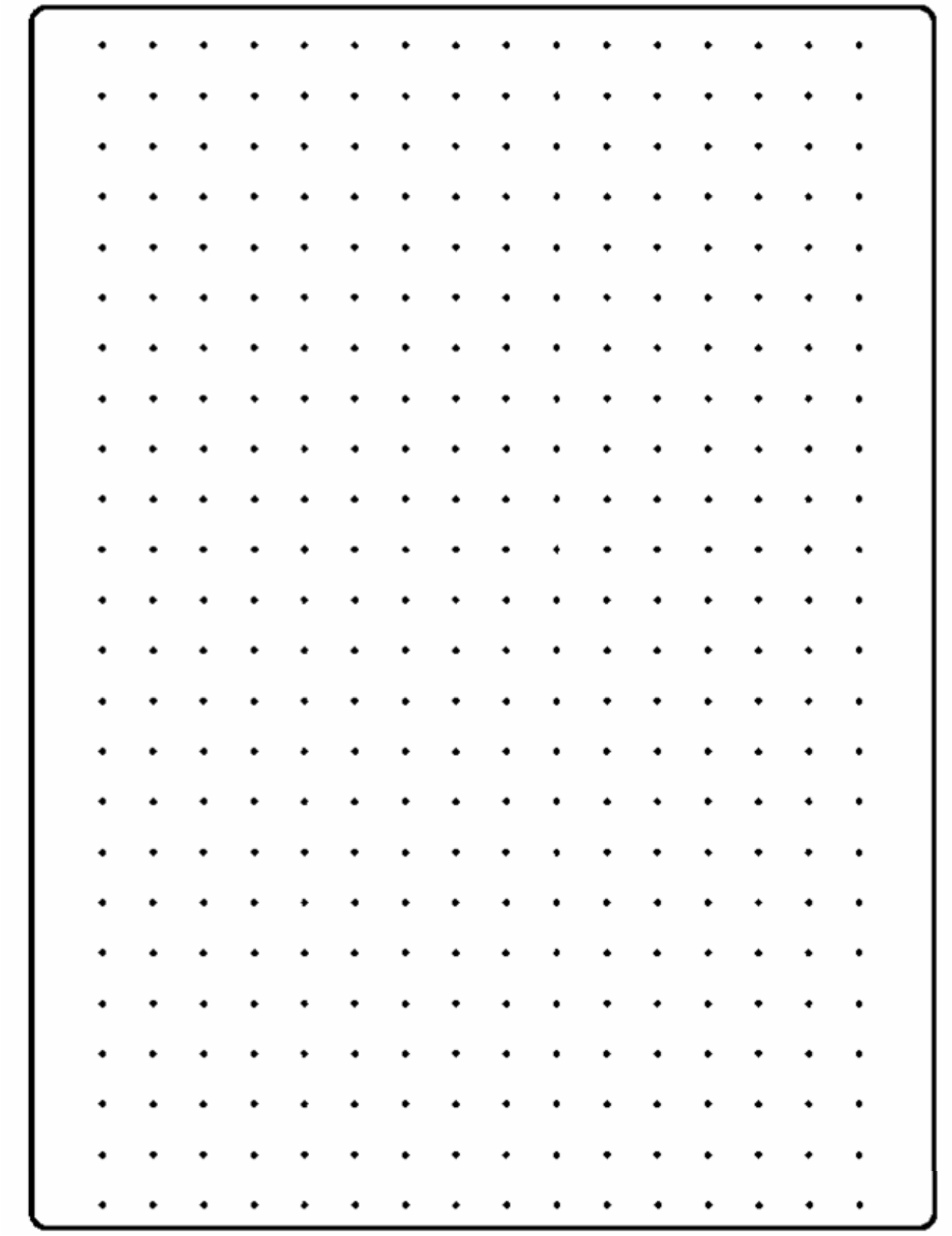






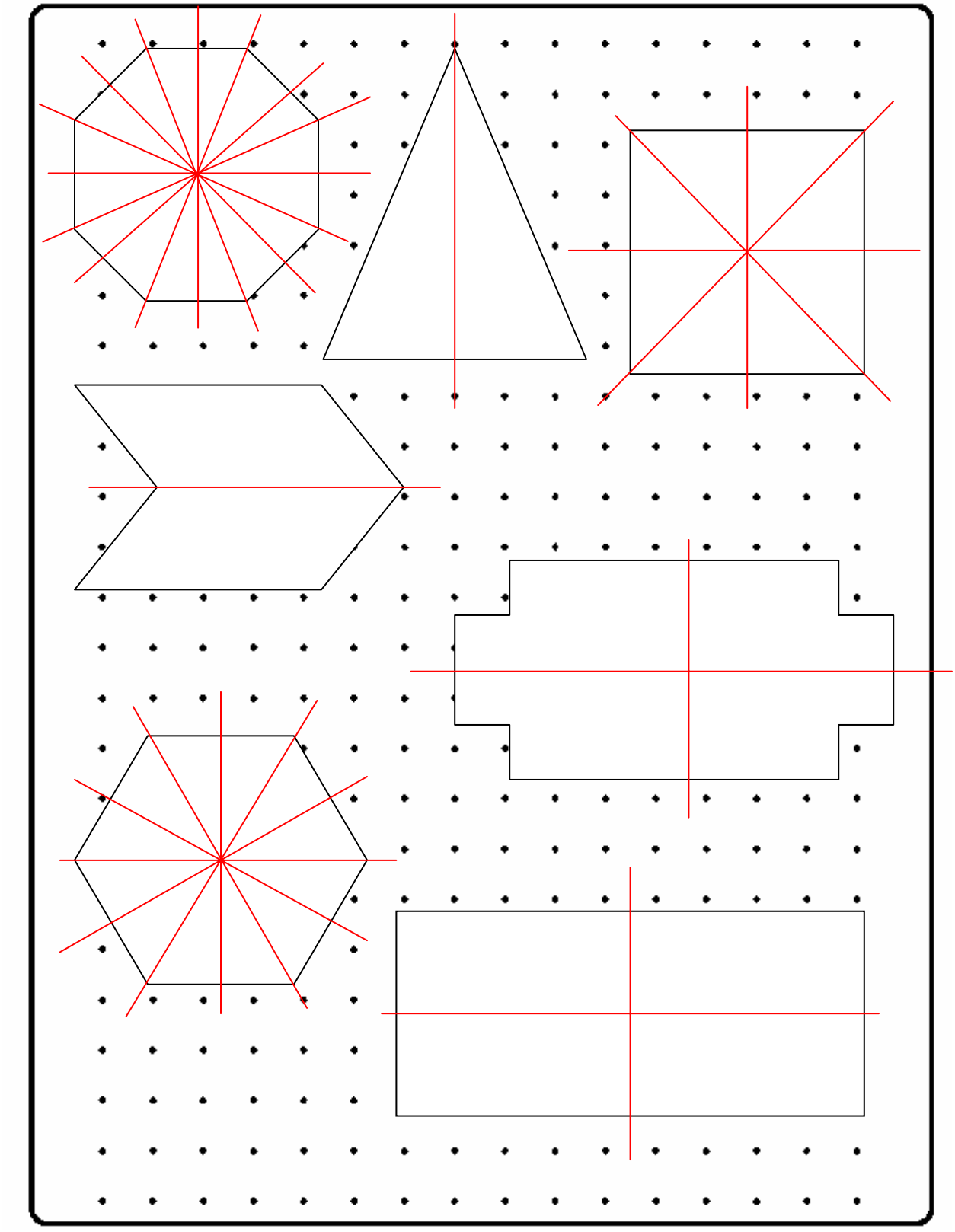


Dot Paper



Name: ANSWER KEY

Symmetry Dot Paper Activity



Name: _____

Alphabet Symmetry

Identify the capital letters that have line symmetry. Then, show all the lines of symmetry.

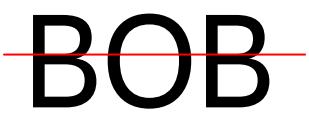
A	B	C	D
E	F	G	H
I	J	K	L
M	N	O	P
Q	R	S	T
U	V	W	X
Y	Z		

Name: _____

Alphabet Symmetry

Using capital letters, write five words, phrases, or names that have horizontal line symmetry. Draw the horizontal line of symmetry.

Example:



1.

2.

3.

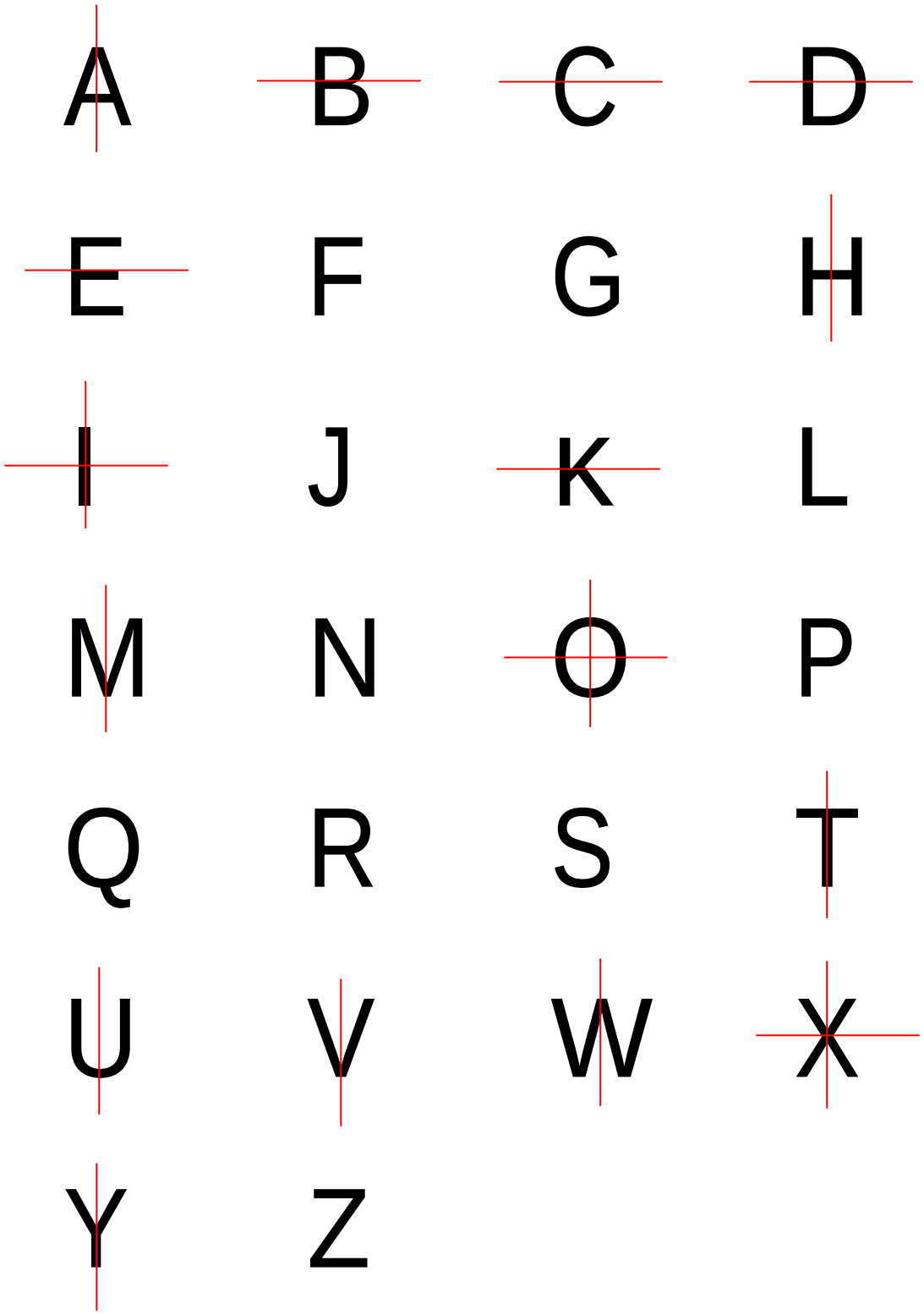
4.

5.

Name: ANSWER KEY

Alphabet Symmetry

Identify the capital letters that have line symmetry. Then, show all the lines of symmetry.



Name: ANSWER KEY

Alphabet Symmetry

Using capital letters, write five words, phrases, or names that have horizontal line symmetry. Draw the horizontal line of symmetry.

Example:

BOB

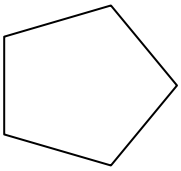
Sample answers:

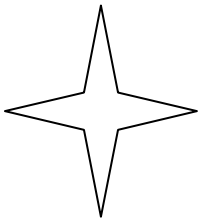
1. BED
2. I DO
3. KICK
4. COOKIE
5. COKE

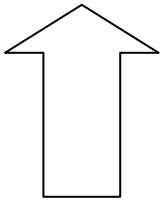
Name: _____

Symmetry Reflection

Draw all the lines of symmetry on each object below. Write the number of lines of symmetry each object has on the line provided.

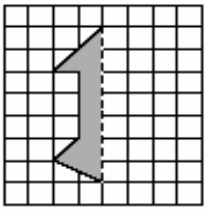
1. _____ 

2. _____ 

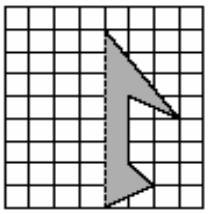
3. _____ 

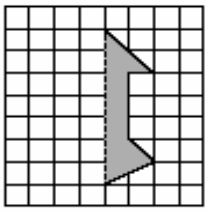
4. Draw your own symmetrical shape in the box below, and show the lines of symmetry.

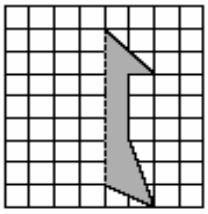
5. Circle the answer to the question below.

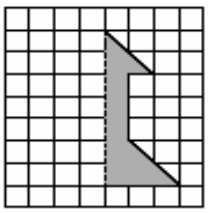


Which of the following would complete the figure shown above so that both sides match exactly when folded on the dotted line?

A 

B 

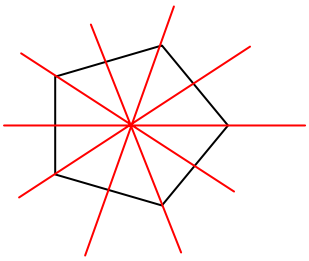
C 

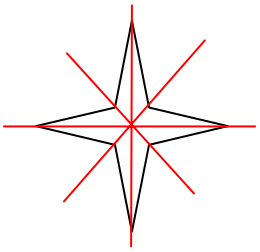
D 

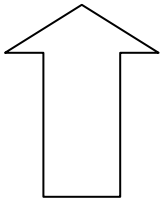
Name: ANSWER KEY

Symmetry Reflection

Draw all the lines of symmetry on each object below. Write the number of lines of symmetry each object has on the line provided.

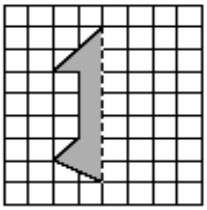
1. 5 

2. 4 

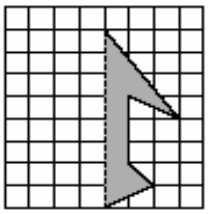
3. 1 

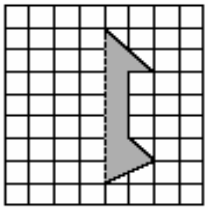
4. Draw your own symmetrical shape in the box below, and show the lines of symmetry.

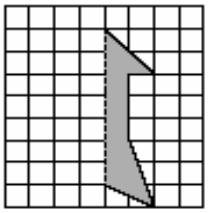
5. Circle the correct answer to the question below.

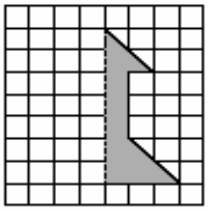


Which of the following would complete the figure shown above so that both sides match exactly when folded on the dotted line?

A 

(B) 

C 

D 

✱ SOL 6.14, 6.15, 7.9, 7.10

Prerequisite SOL

6.14

Lesson Summary

Students use geoboards to make polygons with an increasing number of sides, and they record the shapes on dot paper. (40 minutes)

Materials

Geoboards	Exit Pass	Wire hangers
Rubber bands	Tagboard	
Dot paper (attached)	String	

Vocabulary

polygon. A simple, closed, plane figure formed by three or more straight lines.
triangle. A polygon with three sides.
quadrilateral. A polygon with four sides.
pentagon. A polygon with five sides
hexagon. A polygon with six sides.
heptagon. A polygon with seven sides.
octagon. A polygon with eight sides.
nonagon. A polygon with nine sides.
decagon. A polygon with ten sides.

Warm-up

Have students work in pairs to generate a list of words that have something to do with the concept of three, such as *tricycle, tripod,* etc.

Lesson

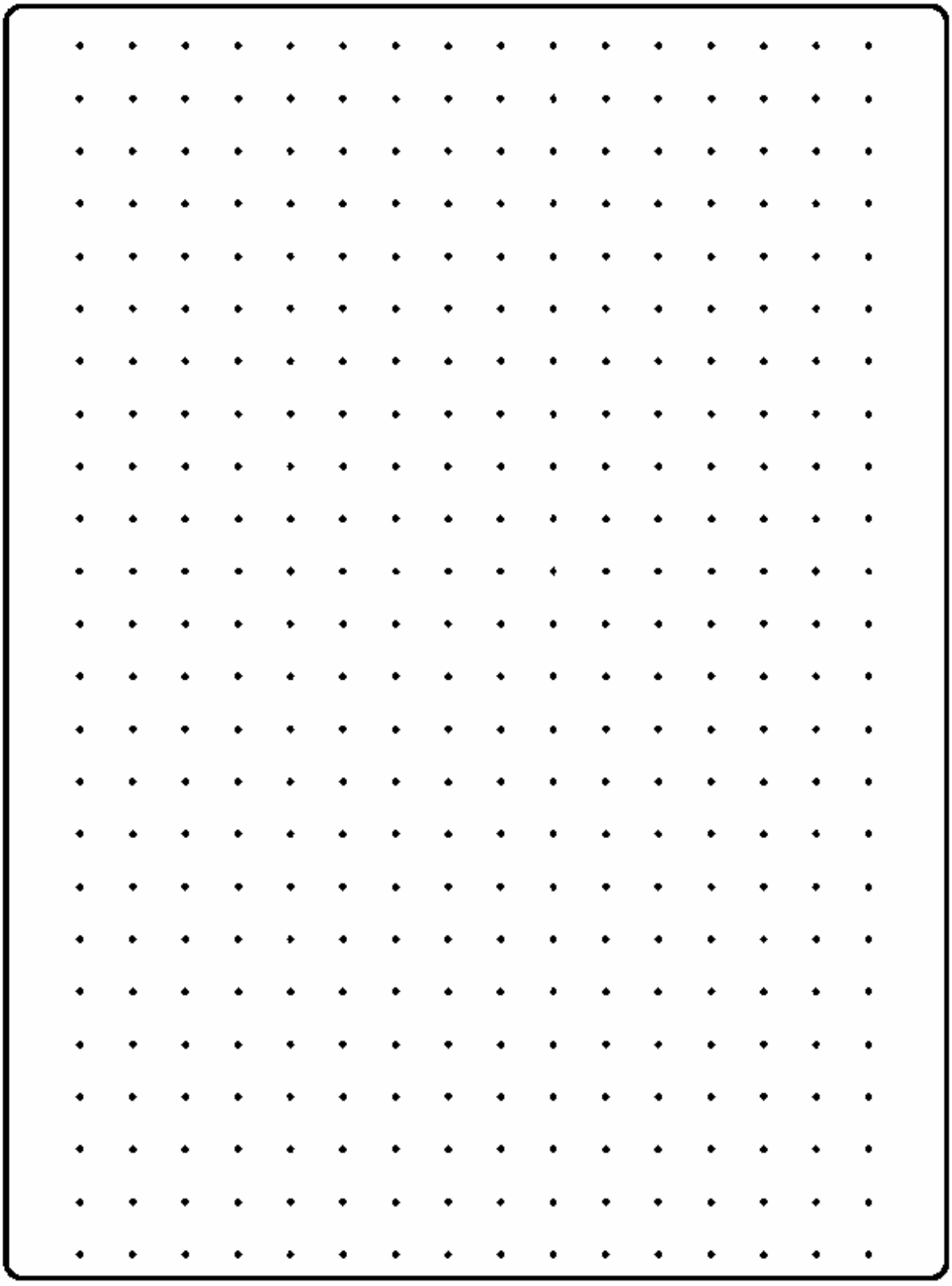
1. Ask the students whether they remember what a polygon is. Remind students that a polygon is a simple, closed figure in a plane and that has line segments as sides. Point out that polygons can have any number of sides. Explain that the prefixes in the names of polygons tell the number of sides: penta = 5, hexa = 6, hepta = 7, octa = 8, nona = 9, and deca = 10. Relate this to the list they generated in the Warm-up. Bring up other instances of prefixes meaning *numbers* of things, such as a *bi*cycle having *two* wheels and a *tri*cycle having *three* wheels.
2. Give each student a geoboard and rubber bands, and instruct students on the appropriate use of them. Ask students to make a triangle on their geoboards. If necessary, model an example on the overhead geoboard.
3. Ask the students to modify the figure on their geoboard by adding one more side, thus making a quadrilateral. Monitor the activity by walking around the room. Have students volunteer their shape and tell why it is a quadrilateral. (because it is a polygon with four sides)
4. Have students draw on dot paper the quadrilateral they created.
5. Continue having the students add a side, drawing and naming the figure each time, until they reach a decagon. If necessary, model how to form each shape on the overhead geoboard, and have the students make the same shapes on their geoboards.
6. Have each student compare his/her drawings of the shapes with those of a partner. Use this opportunity to talk about the fact that all four-sided figures are quadrilaterals (some are squares, some trapezoids, and so forth). This is a good time to reinforce the idea of common properties (e.g., all quadrilaterals have four sides) and distinguishing properties (e.g., all squares have four congruent sides and four right angles.)

7. Have students cut out the polygon figures they drew and trace them onto tagboard. Then, have them cut out the tagboard shapes and construct a polygon mobile by stringing the shapes onto a wire hanger. Display these around the room.

Reflection

Have students complete the Exit Pass by writing a definition and drawing a figure of each polygon in the table.

Dot Paper



Name: _____

Exit Pass

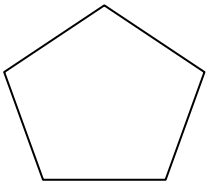
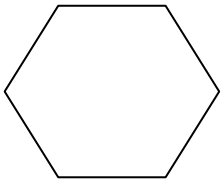
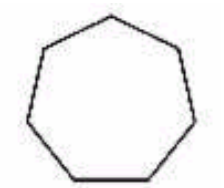
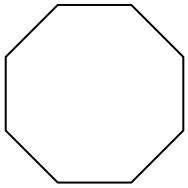
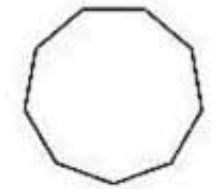
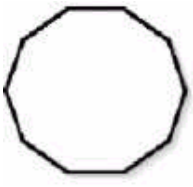
Write a definition and sketch a picture for each vocabulary word below.

WORD	DEFINITION	PICTURE
pentagon		
hexagon		
heptagon		
octagon		
nonagon		
decagon		

Name: ANSWER KEY

Exit Pass

Write a definition and sketch a picture for each vocabulary word below.

WORD	DEFINITION	PICTURE
pentagon	A five-sided polygon	
hexagon	A six-sided polygon	
heptagon	A seven-sided polygon	
octagon	An eight-sided polygon	
nonagon	A nine-sided polygon	
decagon	A ten-sided polygon	

✱ SOL 6.14, 7.9

Prerequisite SOL

None

Lesson Summary

Students construct parallelograms, rectangles, squares, and rhombuses, using D-stix, geo-strips, or toothpicks and marshmallows, and identify the properties of the constructed figures. (approximately 40 minutes)

Materials

Sets of D-stix™, Geo-strips™, or toothpicks and miniature marshmallows
"Quadrilateral Concept Card"
"Types of Quadrilaterals" handouts

Vocabulary

polygon. A simple, closed, plane figure formed by three or more straight lines.
quadrilateral. A polygon with four sides.
parallelogram. A quadrilateral with two pairs of parallel sides.
rectangle. A parallelogram with four right angles.
square. A rectangle with four sides of equal length.
rhombus. A parallelogram with four congruent sides.

Warm-up

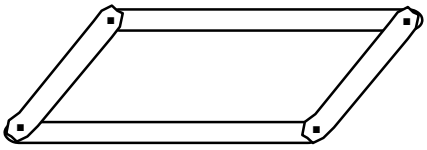
Distribute the "Quadrilateral Concept Cards," and instruct students to work in pairs to complete them. When students are finished, have a class discussion in which they share their responses. Elicit from the class the essential elements of a polygon:

1. Composed of three or more line segments
2. Simple (the segments do not cross)
3. Closed
4. Lies in a plane (is 2-dimensional)

(Note: You may wish to demonstrate the concept of a plane figure by taking a polygon made of wire, which is 2-dimensional, and twisting it so that it is no longer flat; now it is no longer a polygon because it is no longer a plane [2-dimensional] figure.) Have the class work together to agree on class definitions of the terms *polygon* and *quadrilateral*.

Lesson

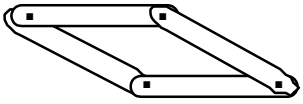
1. Divide the students into small groups, and give each pair a set of D-stix, geo-strips, or toothpicks with marshmallows.
2. Have the partners pick two pairs of congruent pieces of their materials and connect them as shown at right. Have them flex the figure into different positions. Model constructing the quadrilateral and flexing it, if necessary.



3. Ask the students the following questions:
   - What is another name for this quadrilateral?" (parallelogram) Review the definition of *parallelogram* with the class.
   - What stays the same when you flex the parallelogram to different positions? (the lengths of the sides; the sum of the measures of the angles; the perimeter; opposite sides stay parallel; opposite angles stay congruent.)
   - What changes when you flex the parallelogram ? (size of the angles; the area; the lengths of diagonals; the shape)
   - What do you notice about the opposite sides of the parallelogram? (Opposite sides remain parallel and congruent/equal.)

- What is the sum of the measures of the interior angles of the parallelogram? (360°)
- What do you notice about the opposite angles? (They are congruent — equal in measure.)
- If you make one of the angles a right angle, using the square corner of a book or table to check for accuracy, what happens to the other angles? (They become right angles too.)
- Will this always be true when you make one angle of a parallelogram a right angle? (yes)
- How do you know? (The sum of the measures of the angles in a parallelogram is 360°. If one angle measures 90°, its opposite angle, which is congruent, also measures 90°. Subtracting these two angles from 360° leaves 180° for the combined measure of the two remaining angles. These two angles are also congruent since they are opposite angles in a parallelogram; therefore, each angle must measure 90°.)
- Is it still a parallelogram when every angle is 90°? (yes)
- Is it still a quadrilateral when every angle is 90°? (yes)
- Is it still a polygon when every angle is 90°? (yes)
- What other name besides polygon, quadrilateral, or parallelogram can be given to it when every angle is 90°? (rectangle) Review the definition of *rectangle* with the class.

4. Have the partners pick four congruent pieces of their materials and connect them as shown at right. Have them flex the figure into different positions. Model constructing the quadrilateral and flexing it, if necessary.



5. Ask the students the following questions:
   - What is another name for this parallelogram?" (rhombus) Review the definition of *rhombus* with the class.
   - What stays the same when you flex the rhombus to different positions?" (the lengths of the sides; the sum of the measures of the angles; the perimeter; opposite sides stay parallel; opposite angles stay congruent.)
   - What is the sum of the measures of the interior angles of the rhombus? (360°)
   - What changes when you flex the rhombus? (sizes of the angles; the area; the lengths of diagonals; the shape)
   - What do you notice about the opposite angles of the rhombus? (Opposite angles remain congruent/equal.)
   - Is it still a quadrilateral when flexed? (yes)
   - Is it still a polygon when flexed? (yes)
   - If you make one of the angles of the rhombus a right angle, using the square corner of a book or table to check for accuracy, what happens to the other angles? (They become right angles too.)
   - Is it still a parallelogram? (yes)
   - What other name besides polygon, quadrilateral, parallelogram, and rhombus can be given to it when every angle is 90°? (square) Review the definition of *square* with the class.
   - Is it a rectangle? (yes)
   - How do you know? (It has four right angles.)
6. Distribute the "Types of Quadrilaterals" handout, and discuss the definitions of *quadrilateral, parallelogram, rectangle, rhombus,* and *square.* Discuss the examples of each, making sure the students notice their orientations and how each example fits the definition even though it is not necessarily the typical figure usually seen.

Reflection

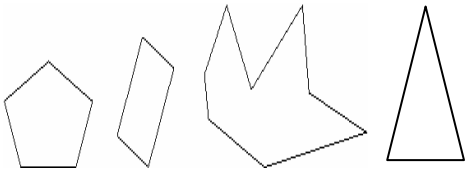
Have students write a letter to a teacher or someone else, explaining an important concept they learned in class today.

Name: _____

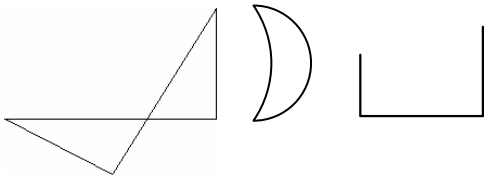
Quadrilateral Concept Card

Polygons

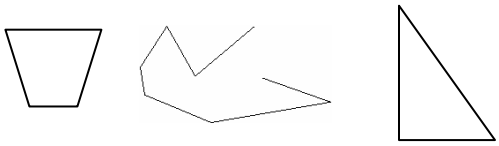
These figures are polygons:



These figures are <u>not</u> polygons:



Which of these figures are polygons? (circle)



Draw your own example of a polygon.

Draw your own example of a non-polygon.

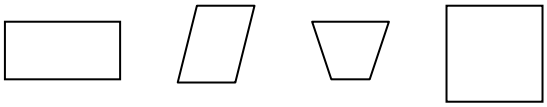
What is a polygon?

<u>A polygon is</u> _____

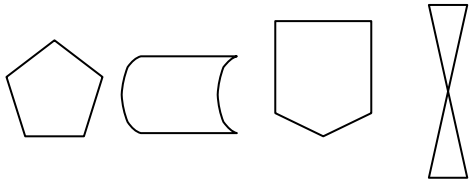
_____.

Quadrilaterals

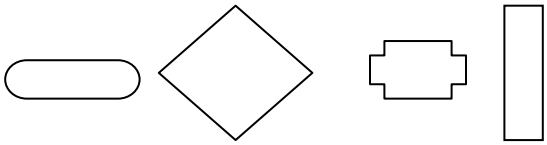
These figures are quadrilaterals:



These figures are <u>not</u> quadrilaterals:



Which of these figures are quadrilaterals? (circle)



Draw your own example of a quadrilateral.

Draw your own example of a non-quadrilateral.

What is a quadrilateral?

<u>A quadrilateral is</u> _____

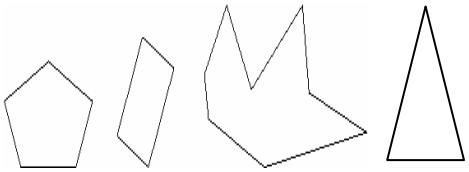
_____.

Name: ANSWER KEY

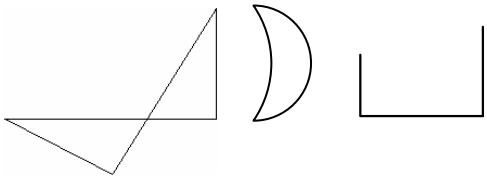
Quadrilateral Concept Card

Polygons

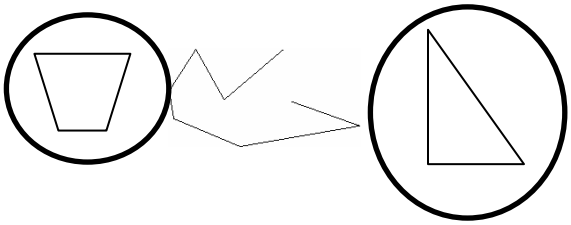
These figures are polygons:



These figures are not polygons:



Which of these figures are polygons? (circle)

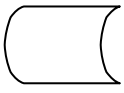


Draw your own example of a polygon.

Drawing will vary.

Draw your own example of a non-polygon.

Drawing will vary. Sample answer:

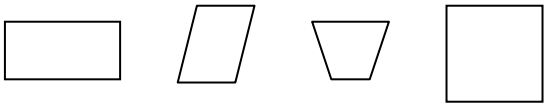


What is a polygon? Sample answer:

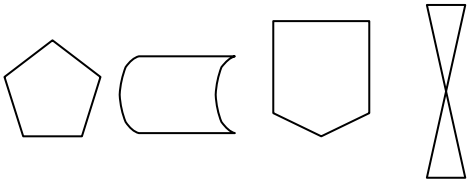
A polygon is a simple, closed, plane figure formed by three or more straight lines.

Quadrilaterals

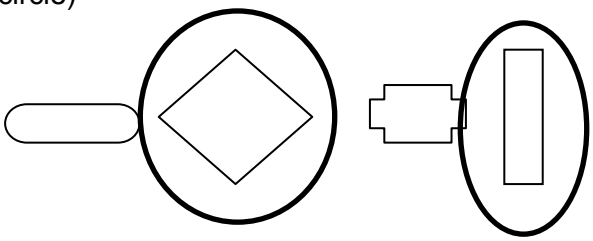
These figures are quadrilaterals:



These figures are not quadrilaterals:



Which of these figures are quadrilaterals? (circle)



Draw your own example of a quadrilateral.

Drawing will vary.

Draw your own example of a non-quadrilateral.

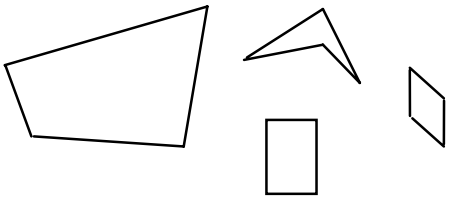
Drawing will vary. Sample answer:

What is a quadrilateral? Sample answer:

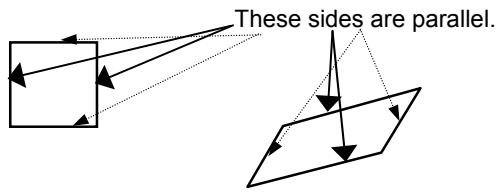
A quadrilateral is a four-sided polygon.

Types of Quadrilaterals

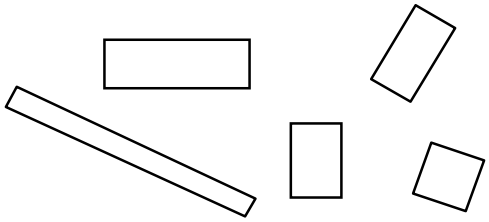
A **quadrilateral** is a polygon with **four sides.**



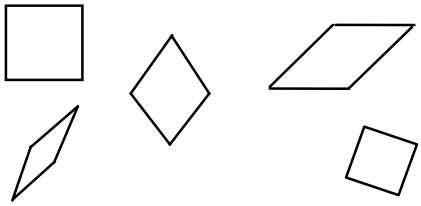
A **parallelogram** is a quadrilateral with **two pairs of parallel sides.**



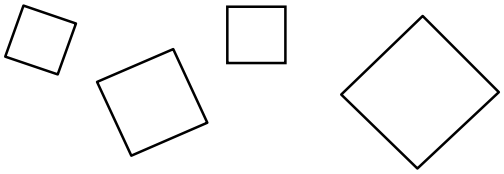
A **rectangle** is a quadrilateral with **four right angles.**



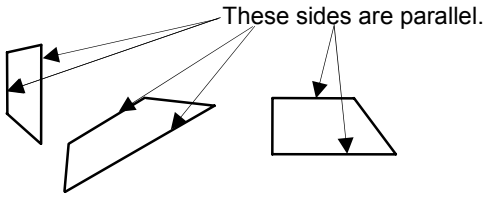
A **rhombus** is a quadrilateral with **four congruent sides.**



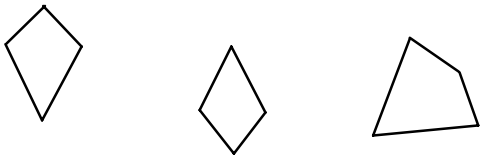
A **square** is a quadrilateral with **four right angles** and **four congruent sides.**



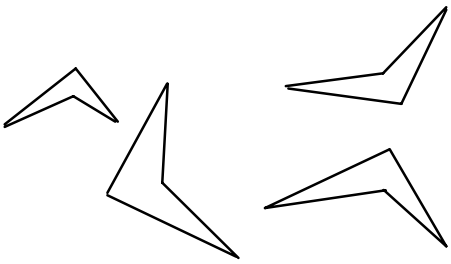
A **trapezoid** is a quadrilateral with **exactly one pair of parallel sides.**



A **kite** is a **convex** quadrilateral with **two distinct pairs of adjacent congruent sides.**



A **dart** is a **concave** quadrilateral.



✱ SOL 6.14, 7.9

Prerequisite SOL

This lesson should be done after the previous lesson, which includes the "Types of Quadrilaterals" handout, so that students are familiar with the terminology for and properties of quadrilaterals.

Lesson Summary

Students match quadrilaterals with various descriptions listed on an activity sheet and a quadrilateral table, and they determine which sets are identical, attach labels to each category, and create a quadrilateral family tree. (approximately 40 minutes)

Materials

"Warm-up" worksheets
Sets of "Quadrilateral Sorting Pieces"
"Quadrilateral Activity" worksheets
"Quadrilateral Table" worksheets
"Quadrilateral Family Tree" worksheets
"Quadrilateral Puzzle" worksheets

Vocabulary

polygon. A simple, closed, plane figure formed by three or more straight lines.
quadrilateral. A polygon with four sides.
parallelogram. A quadrilateral with two pairs of parallel sides.
rectangle. A parallelogram with four right angles.
rhombus. A parallelogram with four congruent sides.
square. A rectangle with four sides of equal length.
trapezoid. A quadrilateral with exactly one pair of parallel sides.

Warm-up

Give students 10 minutes to complete the "Warm-up" worksheet. After time is up, have them share their drawings, discussing the shapes as a whole group.

Lesson

1. Copy the 12 "Quadrilateral Sorting Pieces" onto card stock and cut them out, making enough sets of 12 pieces to give a complete set to each student. Alternatively, have each student cut out his/her own set.
2. Distribute the sets of sorting pieces and the "Quadrilateral Activity," "Quadrilateral Table," and "Quadrilateral Family Tree" worksheets.
3. Divide the students into small groups, and direct each group to use their sorting pieces to answer the questions on the "Quadrilateral Activity" worksheet and to complete the "Quadrilateral Table."
4. After the students have completed the worksheet and table, have pairs of groups compare their answers and reconcile any discrepancies.
5. For the "Quadrilateral Family Tree," students can work in small groups or, if you feel they need guidance, as a large group.

Reflection

For the reflection, have students complete the "Quadrilateral Puzzle."

Name: _____

Warm-up

For each question, draw a geometric shape that has all of the properties listed. Write the name of the shape on the line provided.

1. Opposite sides are congruent.
   Opposite sides are parallel.
   Opposite angles are congruent.

   _____

2. All sides are congruent.
   Opposite sides are parallel.
   Opposite angles are equal.
   No angles are equal to 90°.

   _____

3. All angles are right angles.
   Opposite sides are congruent.
   Opposite sides are parallel.

   _____

4. Has four sides.
   Has two pairs of congruent adjacent sides.

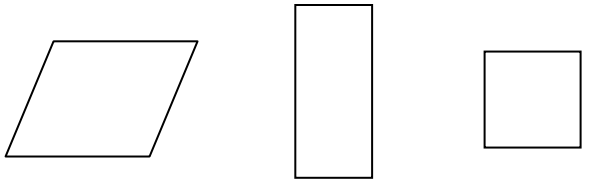
   _____

Name: ANSWER KEY

Warm-up

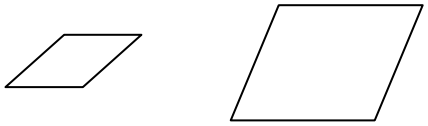
For each question, draw a geometric shape that has all of the properties listed. Write the name of the shape on the line provided.

1. Opposite sides are congruent.
   Opposite sides are parallel.
   Opposite angles are congruent.



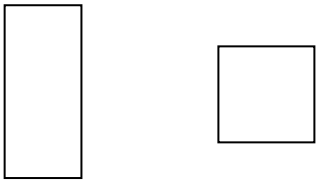
Sample answers: parallelogram, rectangle, square

2. All sides are congruent.
   Opposite sides are parallel.
   Opposite angles are equal.
   No angles are equal to 90°.



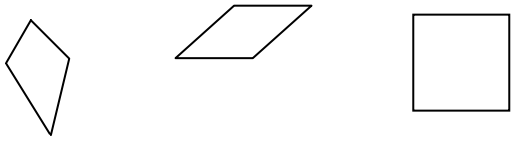
Sample answers: rhombus, parallelogram

3. All angles are right angles.
   Opposite sides are congruent.
   Opposite sides are parallel.



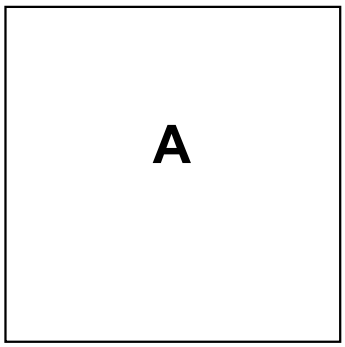
Sample answers: rectangle, square

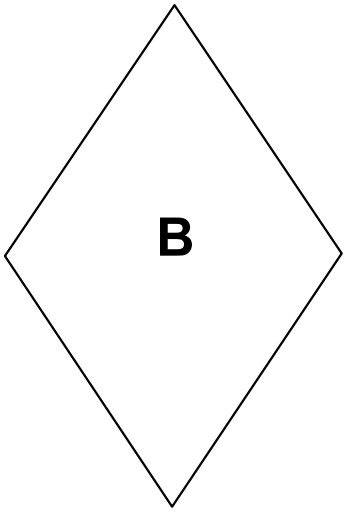
4. Has four sides.
   Has two pairs of congruent adjacent sides.

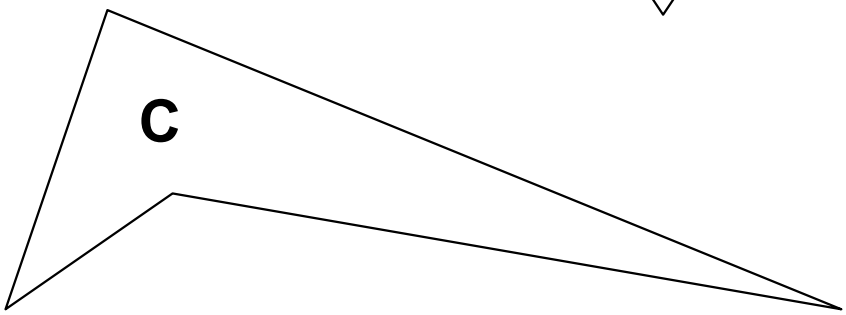


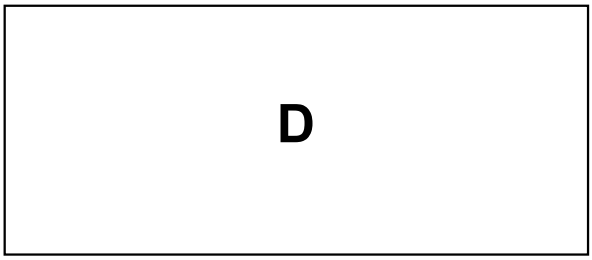
Sample answers: kite, rhombus, square

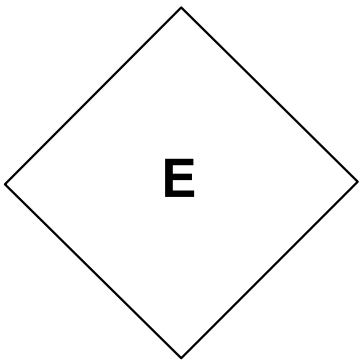
Quadrilateral Sorting Pieces

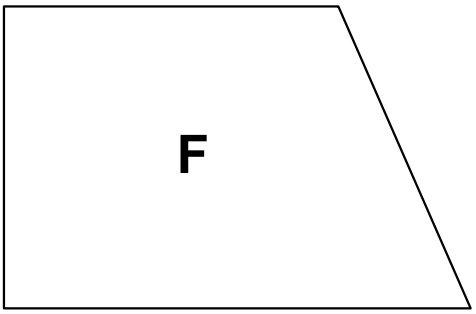




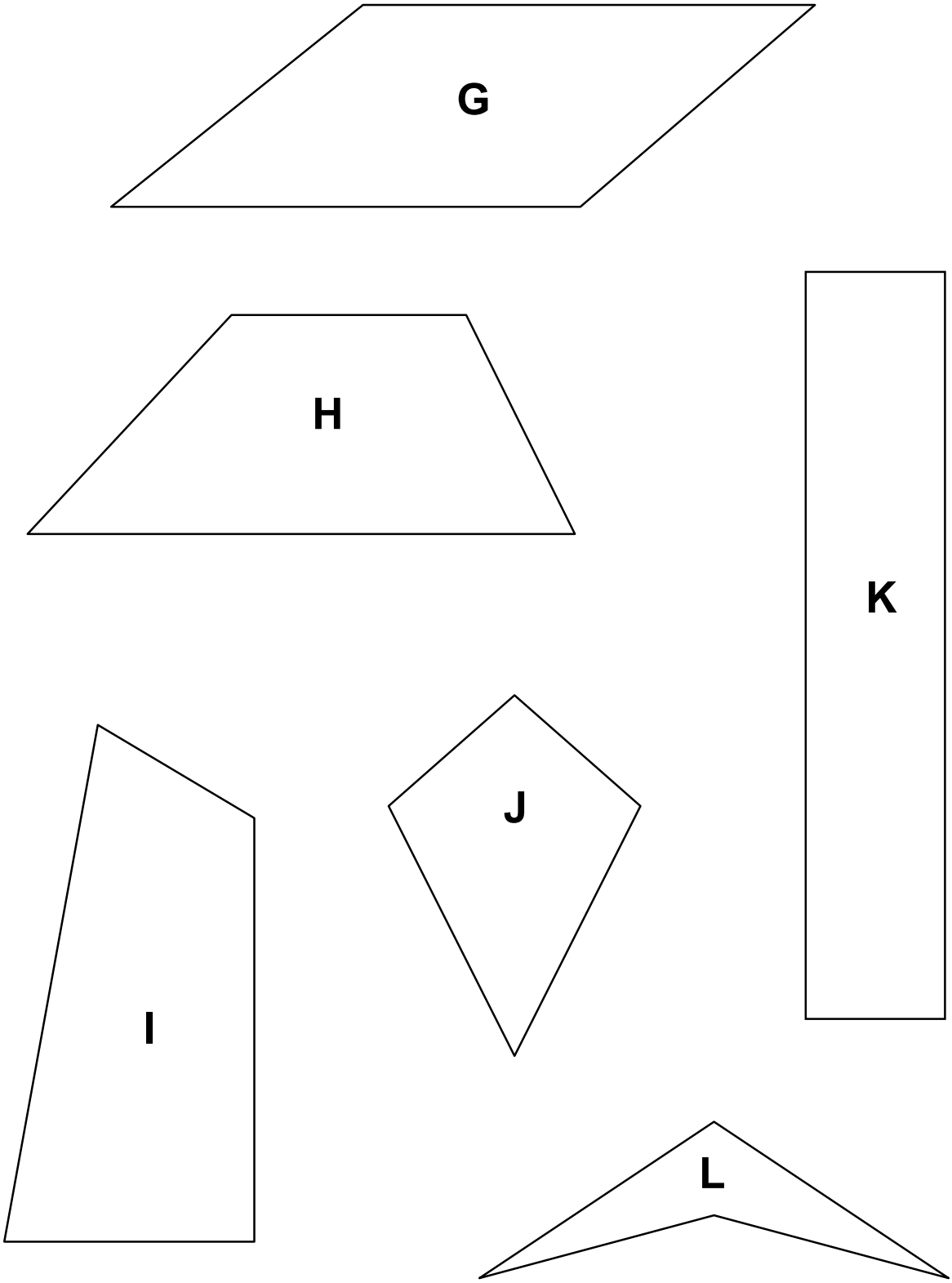








Quadrilateral Sorting Pieces



Name: _____

Quadrilateral Activity

Spread out your quadrilateral pieces with the letters facing up so you can see them. Find all of the quadrilaterals that have four right angles, and list them by letter alphabetically on the Question #1 answer line. Then, consider all of the quadrilaterals again. Find all of the quadrilaterals that have exactly one pair of parallel sides, and list them by letter alphabetically in Question #2 answer line. Continue in this manner until you complete all the questions.

1. Has four right angles: _____

2. Has exactly one pair of parallel sides: _____

3. Has two pairs of congruent opposite sides: _____

4. Has four congruent sides: _____

5. Has two pairs of parallel opposite sides: _____

6. Has two pairs of congruent adjacent sides, but not all sides are congruent: _____

7. Has congruent opposite angles: _____

8. Does not have four sides: _____

9. Has four congruent angles: _____

10. Which lists are the same? _____What name can be used to describe quadrilaterals with these properties? _____

Name: ANSWER KEY

Quadrilateral Activity

Spread out your quadrilateral pieces with the letters facing up so you can see them. Find all of the quadrilaterals that have four right angles, and list them by letter alphabetically on the Question #1 answer line. Then, consider all of the quadrilaterals again. Find all of the quadrilaterals that have exactly one pair of parallel sides, and list them by letter alphabetically in Question #2 answer line. Continue in this manner until you complete all the questions.

1. Has four right angles: A, D, E, K

2. Has exactly one pair of parallel sides: F, H

3. Has two pairs of congruent opposite sides: A, B, D, E, G, K

4. Has four congruent sides: A, B, E

5. Has two pairs of parallel opposite sides: G, K, A, B, D, E

6. Has two pairs of congruent adjacent sides, but not all sides are congruent: L, J

7. Has congruent opposite angles: A, B, D, E, G, K

8. Does not have four sides: no examples

9. Has four congruent angles: A, D, E, K

10. Which lists are the same? #3, 5, and 8 What name can be used to describe quadrilaterals with these properties? parallelograms

Name: _____

Quadrilateral Table

Using the results of the "Quadrilateral Activity" worksheet, place a check mark in the appropriate spaces to show which figures have which properties.

PROPERTY OF FIGURE	**TYPES OF POLYGONS**					
	Quadrilateral	**Parallelogram**	**Rectangle**	**Rhombus**	**Square**	**Trapezoid**
All four angles are right angles.						
Opposite sides are parallel.						
Opposite angels are congruent.						
All sides are congruent.						
All angles are congruent.						
May contain a right angle.						
Opposite sides are congruent.						
Has exactly one pair of parallel sides.						
Has two pairs of congruent adjacent sides.						

Name: ANSWER KEY

Quadrilateral Table

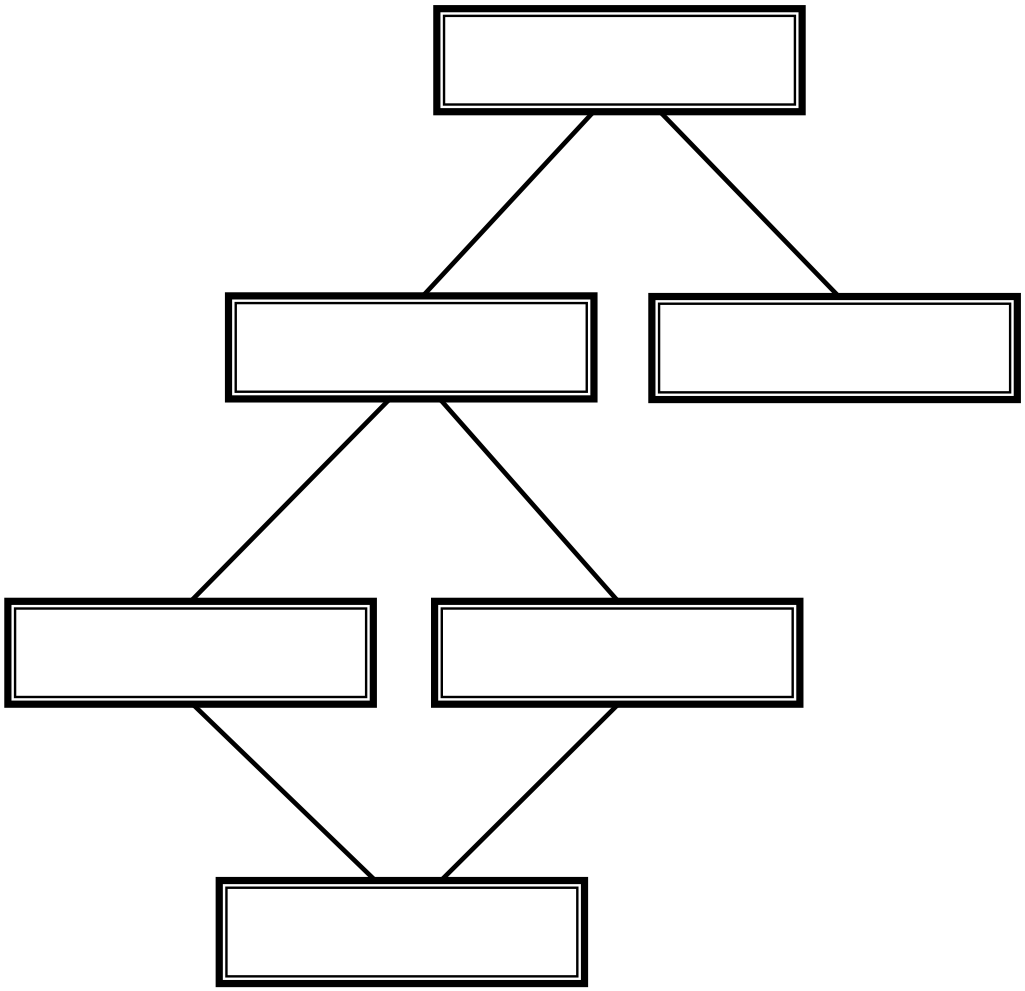
Using the results of the "Quadrilateral Activity" worksheet, place a check mark in the appropriate spaces to show which figures have which properties.

PROPERTY OF FIGURE	TYPES OF POLYGONS					
	Quadrilateral	**Parallelogram**	**Rectangle**	**Rhombus**	**Square**	**Trapezoid**
All four angles are right angles.			√		√	
Opposite sides are parallel.		√	√	√	√	
Opposite angels are congruent.		√	√	√	√	
All sides are congruent.				√	√	
All angles are congruent.			√		√	
May contain a right angle.	√		√		√	√
Opposite sides are congruent.		√	√	√	√	
Has exactly one pair of parallel sides.						√
Has two pairs of congruent adjacent sides.				√	√	

Name: _____

Quadrilateral Family Tree

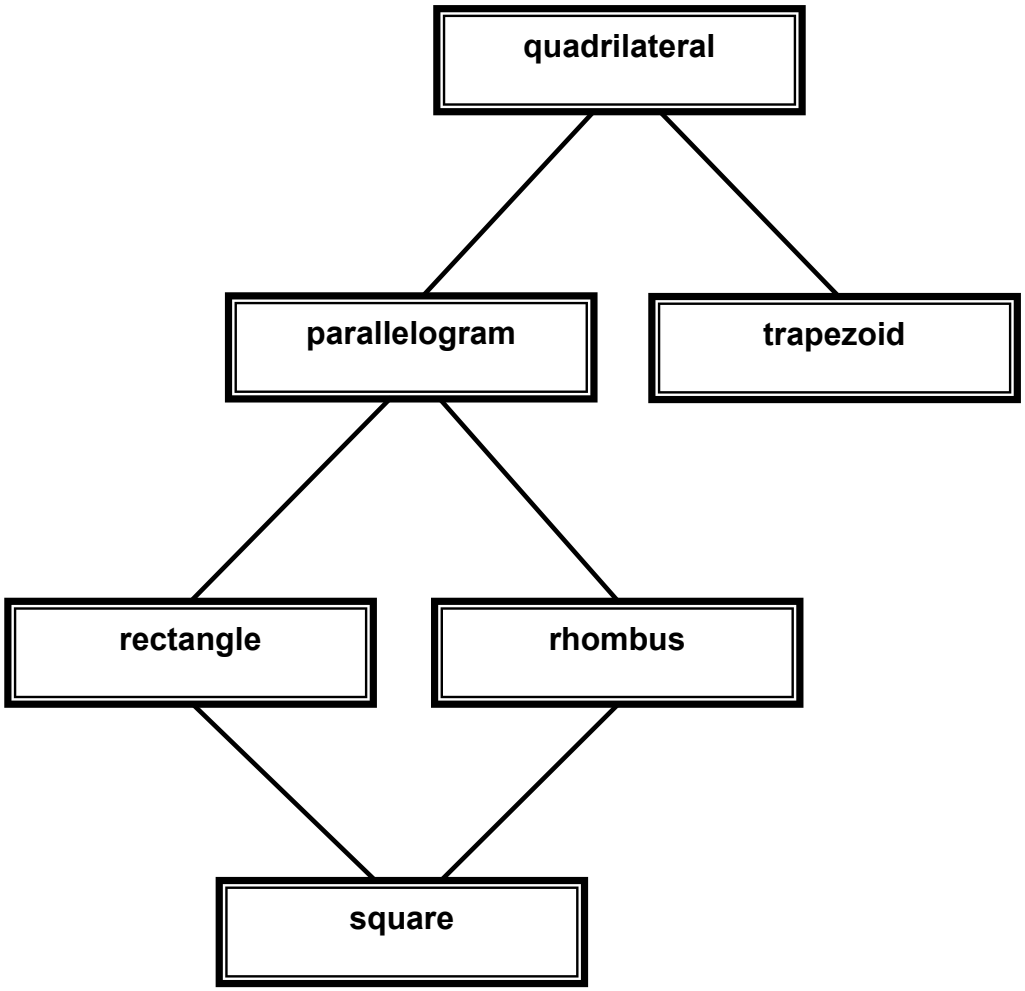
Fill out the family tree by writing the names *quadrilateral, rectangle, square, rhombus, parallelogram,* and *trapezoid* into the appropriate blocks on the diagram.



Name: ANSWER KEY

Quadrilateral Family Tree

Fill out the family tree by writing the names *quadrilateral, rectangle, square, rhombus, parallelogram,* and *trapezoid* into the appropriate blocks on the diagram.

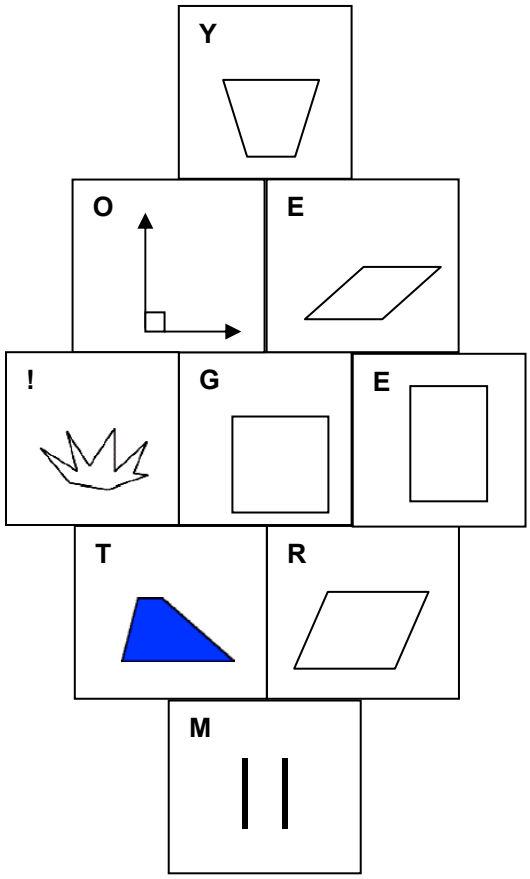


Name: _____

Quadrilateral Puzzle

Match the numbered vocabulary word with the block in the puzzle that shows an example of that word. Place the letter or symbol from the puzzle block onto the numbered line below to solve the puzzle. Each block may be used only once even though the shapes in some blocks have more than one name.

1. **square**
2. **rectangle**
3. **right angle**
4. **parallel lines**
5. **rhombus**
6. **trapezoid**
7. **parallelogram**
8. **quadrilateral**
9. **polygon**



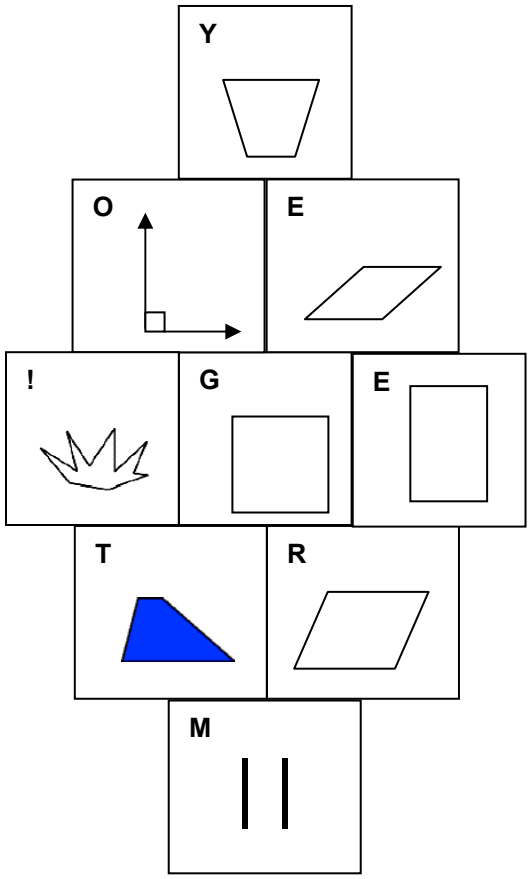
1	2	3	4	5	6	7	8	9

Name: ANSWER KEY

Quadrilateral Puzzle

Match the numbered vocabulary word with the block in the puzzle that shows an example of that word. Place the letter or symbol from the puzzle block onto the numbered line below to solve the puzzle. Each block may be used only once even though the shapes in some blocks have more than one name.

1. **square**
2. **rectangle**
3. **right angle**
4. **parallel lines**
5. **rhombus**
6. **trapezoid**
7. **parallelogram**
8. **quadrilateral**
9. **polygon**



G	E	O	M	E	T	R	Y	!
1	2	3	4	5	6	7	8	9

✱ SOL 6.15

Prerequisite SOL

6.13a, 6.13b

Lesson Summary

Students compare line segments, angles, and polygons for congruence, using tracing and direct measurement. (40 minutes)

Materials

Protractors	"Warm-up" worksheets
Centimeter rulers	"Determining Congruence" worksheets
Permanent markers	"Determining Congruence Tables" worksheets
Patty paper or tracing paper	"Reflecting" worksheets

Vocabulary

congruent. Exactly the same in size and shape.

Warm-up

Distribute the "Warm-up" worksheets, and if necessary, explain to students or remind them how to measure using a centimeter ruler. After they have completed the worksheet, go over the answers before going on to the lesson.

Lesson

1. Explain to students that they are going to compare two geometric images in order to reach one of two conclusions: (1) they are congruent, or (2) they are noncongruent.
2. Distribute the "Determining Congruence" and the "Determining Congruence Tables" worksheets.
3. Part A: Have students measure each pair of line segments, using a centimeter ruler, and record their measurements on the "Determining Congruence Table." Have them compare the two measurements of the pairs of segments. If the two measurements are the same, the two line segments are congruent; if the two measurements are different, the two line segments are noncongruent. (Note: It is important for students to fully understand that line segments and other shapes may be congruent even if they are oriented differently. If students need reinforcement with this concept, have them practice reorienting pairs of congruent line segments and pairs of congruent figures.
4. Part B: Have students measure each angle in degrees, using a protractor, and record the measures of the angles in the "Determining Congruence Table." Have students compare the measures of the two angles: if the two angles have the same measure, then the two angles are congruent; if the two angles have different measures, then the two angles are noncongruent.
5. Part C. Distribute patty paper or tracing paper and permanent markers. Have students trace on the paper one of the polygons in each pair, using a permanent marker, and compare the pair of polygons by placing the traced polygon on top of the other polygon in the pair. If they are an exact match in size and shape, then the two polygons are congruent; if the two polygons differ in size and/or shape, then the two polygons are noncongruent.

Reflection

Have students answer the questions on the "Reflecting" sheet. Review the responses as you walk around and check the students' work.

Name: _____

Warm-up

Measure each line segment, using a centimeter ruler, and record each measurement.

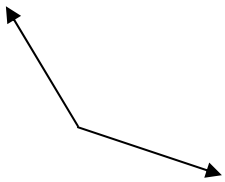
1. $\overline{KM}$ Measure = _____

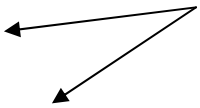
2. $\overline{GT}$ Measure = _____

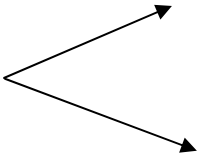
3. $\overline{WR}$ Measure = _____

4. $\overline{EL}$ Measure = _____

Measure each angle in degrees, using a protractor, and record each measure.

5.  Measure = _____

6.  Measure = _____

7.  Measure = _____

8. Define *congruent*: _____

Name: ANSWER KEY

Warm-up

Measure each line segment, using a centimeter ruler, and record each measurement.

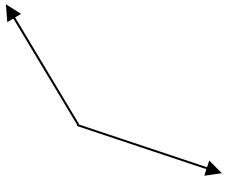
1. K M — Measure = 4 1/2 cm or 4.5 cm

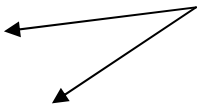
2. G T — Measure = 7 9/10 cm or 7.9 cm

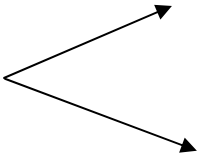
3. W R — Measure = 2 9/10 cm or 2.9 cm

4. E L — Measure = 1 6/10 = 1 3/5 cm or 1.6 cm

Measure each angle in degrees, using a protractor, and record each measure.

5.  Measure = 139°

6.  Measure = 22°

7.  Measure = 44°

8. Define *congruent*: Answers will vary, e.g., "Having the same size and shape."

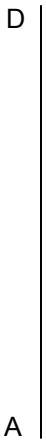
Name: _____

Determining Congruence

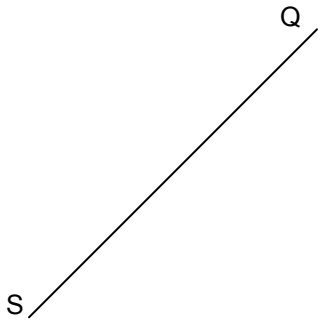
Part A

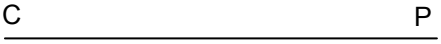
Measure each line segment in each pair, using a centimeter ruler, and record each measurement in the table. Then, determine whether the two line segments in each pair are congruent or noncongruent. Record your answers in the table.

1.

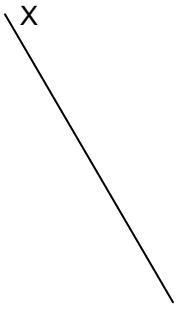


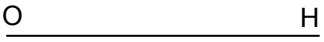
2.





3.





Name: _____

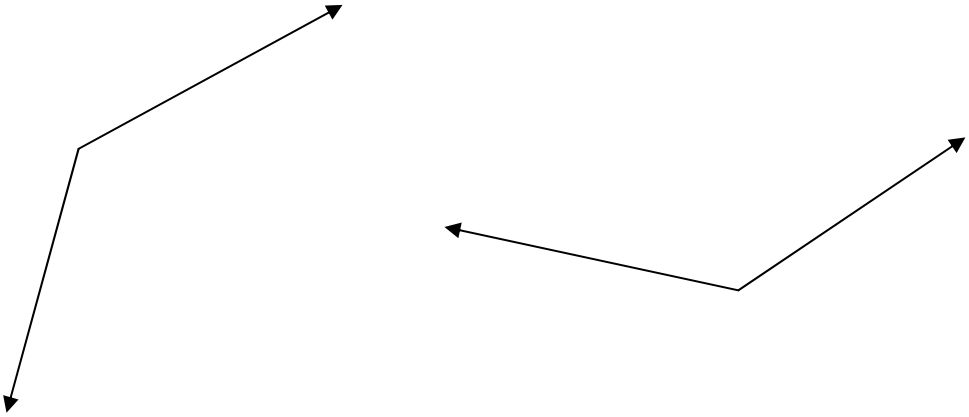
Determining Congruence

Part B

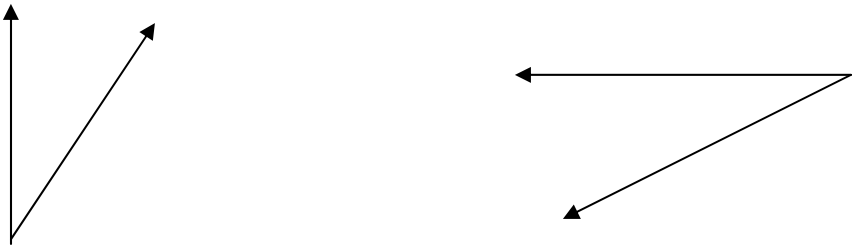
Measure each angle in each pair, using a protractor, and record each measurement in the table. Then, determine whether the two angles in each pair are congruent or noncongruent. Record your answers in the table.

4.

5.



6.

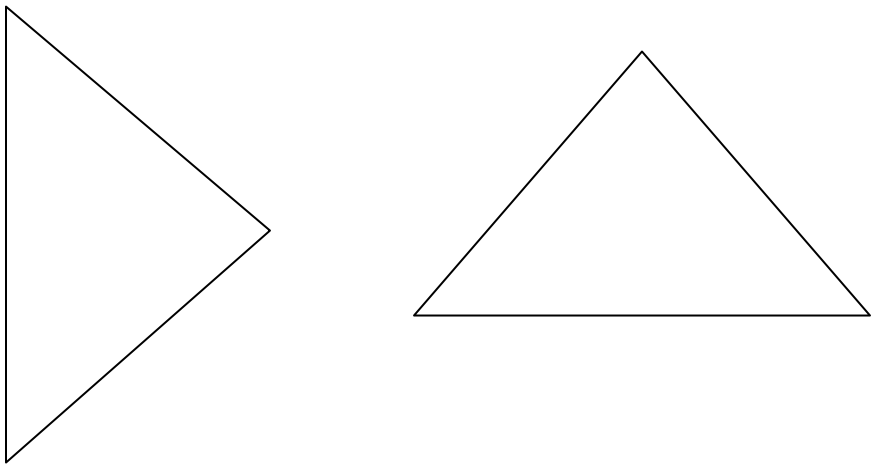


Name: _____

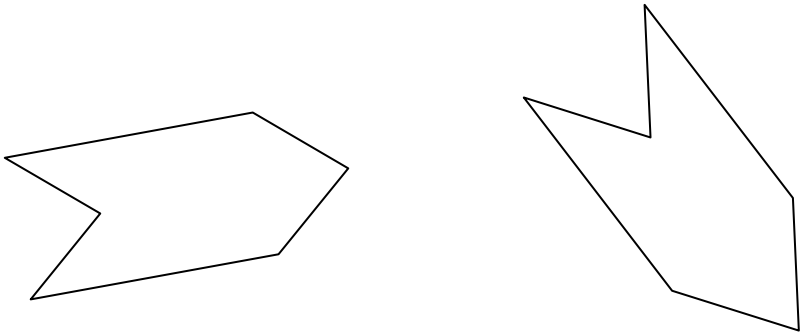
Determining Congruence

Part C

Trace one of the polygons in each pair, using patty paper or tracing paper and a marker. Then, place the tracing over the other polygon in the pair to determine whether the two polygons are congruent or noncongruent. Record your answers in the table.

7. 

8. 

9. 

Name: _____

Determining Congruence Tables

Part A

Number	Measure Line Segment 1	Measure Line Segment 2	Congruent or Noncongruent
1			
2			
3			

Part B

Number	Measure Angle	Measure Angle 2	Congruent or Noncongruent
4			
5			
6			

Part C

Number	Congruent or Noncongruent
7	
8	
9	

Name: ANSWER KEY

Determining Congruence Tables

Part A

Number	Measure Line Segment 1	Measure Line Segment 2	Congruent or Noncongruent
1	6 7/10 cm or 6.7 cm	6 7/10 cm or 6.7 cm	Congruent
2	5 4/10 = 5 2/5 cm or 5.4 cm	5 7/10 cm or 5.7 cm	Noncongruent
3	4 4/10 = 4 2/5 cm or 4.4 cm	4 1/10 cm or 4.1	Noncongruent

Part B

Number	Measure Angle	Measure Angle 2	Congruent or Noncongruent
4	45°	74°	Noncongruent
5	134°	134°	Congruent
6	33°	27°	Noncongruent

Part C

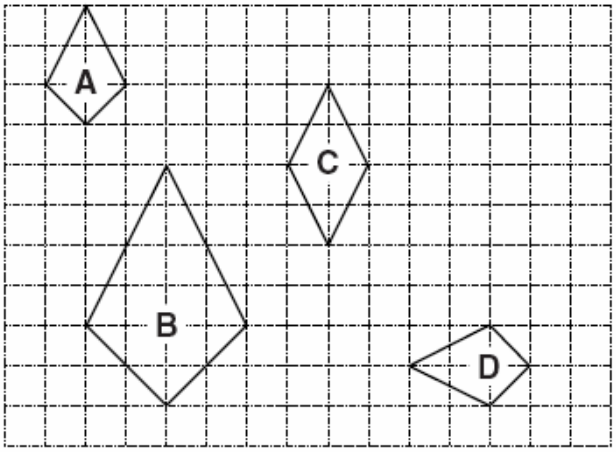
Number	Congruent or Noncongruent
7	Congruent
8	Noncongruent
9	Congruent

Name: _____

Reflecting

1. To the right is a practice SOL question. Circle your answer.

Which figures appear to be congruent?



A A and B
B B and D
C C and D
D D and A

2. Explain why you chose that answer.

_____

_____

_____

_____

3. Draw two congruent line segments.

4. Draw two congruent angles.

Name: ANSWER KEY

Reflecting

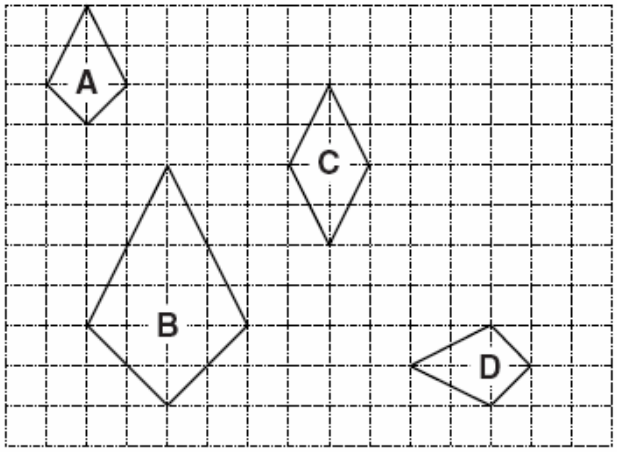
1. To the right is a practice SOL question. Circle your answer.

   D

2. Explain why you chose that answer.

   Answers will vary, e.g. “A and D are the same size.” “A and D are made up of the same number of grid boxes.”

Which figures appear to be congruent?



A A and B
B B and D
C C and D
(D) D and A

3. Draw two congruent line segments.

4. Draw two congruent angles.

✱ SOL 7.11

Prerequisite SOL

None

Lesson Summary

Students sort a set of rectangles into three groups and determine the similarity relationships. (30 minutes)

Materials

Sets of rectangles (see below)
"Alphabet Similarity" worksheets
"Similar Figures Recording Sheet"
Graph paper
"Reflecting on Similar Figures" worksheets

Vocabulary

similar figures. Two figures that are exactly the same in shape but not necessarily the same in size.

Warm-up

Review the meaning of the word *congruent* — having exactly the same size and shape. Illustrate the definition by writing two congruent capital *Q*s on the board. Then, write a large *Q* and a smaller-size *Q*. Explain to the students that the *Q*s in this second pair are *similar* but noncongruent. Once students can give you other examples of similar letters, pictures, etc., have them complete the "Alphabet Similarity" worksheet. Discuss the answers before going on to the lesson.

Lesson

1. In advance of the lesson, make a set of 14 rectangles for each pair of students. Cut them from grid paper in the following sizes: 1 x 1, 1 x 2, 1 x 4, 2 x 4, 2 x 8, 3 x 3, 3 x 6, 3 x 12, 4 x 8, 4 x 16, 5 x 5, 5 x 10, 7 x 7,10 x 10. Draw all diagonals on the rectangles before photocopying them and cutting them out.
2. Distribute the sets of rectangles. Have student pairs divide the rectangles into three groups with the members of each group having the same shape but differing in size. Students should find that one group consists of five squares of different sizes (1 x 1, 3 x 3, 5 x 5, 7 x 7, and 10 x 10). Another group consists of the 1 x 2, 2 x 4, 3 x 6, 4 x 8, and 5 x 10 rectangles. The third group consists of the 1 x 4, 2 x 8, 3 x 12, and 4 x 16 rectangles.
3. Once students grouped the rectangles, have them arrange each group from smallest to largest and look at the relationships among members of the same group. Suggest to students that they stack the members of each group on top of each other, starting with the largest. This will allow them to line up the diagonals.
4. Once students have them arranged, lead a class discussion based on the following questions:
   - What patterns do you see within each family? (Have them focus on length and width.)
   - What do you notice about the diagonals in each group of rectangles?
   - How could you determine another member of the group?
5. Have students complete the recording sheet with the information from the rectangles in each group.
6. Discuss the following questions:
   - Within a group, what patterns do you notice going down the chart?
   - Within a group, what patterns do you notice going across, from width to length?
7. Have students create ratios of width to length for each group. Ask them what they notice about each of the fractions in each set. (They are equivalent.)
8. Based on this discussion, have students define *similar figures.*
9. To extend this activity, have students graph the data by graphing the length and width of each rectangle. It works best to use a different color for each set. Students should see that the coordinates associated with a given set form a line.

10. Have students discuss the following questions based on the graphs:
    - How can you use the graph to find another member of a group?
    - Given a rectangle, how can you tell if it is similar to the ones already graphed?

Reflection

Have students complete the “Reflecting on Similar Figures” worksheet.

Name: _____

Alphabet Similarity

Determine whether the pairs of upper and lower case letters are similar or not.

Aa	**Bb**	**Cc**	**Dd**	**Ee**
Ff	**Gg**	**Hh**	**Ii**	**Jj**
Kk	**Ll**	**Mm**	**Nn**	**Oo**
Pp	**Qq**	**Rr**	**Ss**	**Tt**
Uu	**Vv**	**Ww**	**Xx**	**Yy**
Zz				

Name: ANSWER KEY

Alphabet Similarity

Determine whether the pairs of upper and lower case letters are similar or not.

Aa	**Bb**	**Cc** Similar	**Dd**	**Ee**
Ff	**Gg**	**Hh**	**Ii**	**Jj**
Kk Similar	**Ll**	**Mm**	**Nn**	**Oo** Similar
Pp Similar	**Qq**	**Rr**	**Ss** Similar	**Tt**
Uu Similar	**Vv** Similar	**Ww** Similar	**Xx** Similar	**Yy**
Zz Similar				

Name: _____

Similar Figures Recording Sheet

GROUP ONE

Rectangle	Width	Length

GROUP TWO

Rectangle	Width	Length

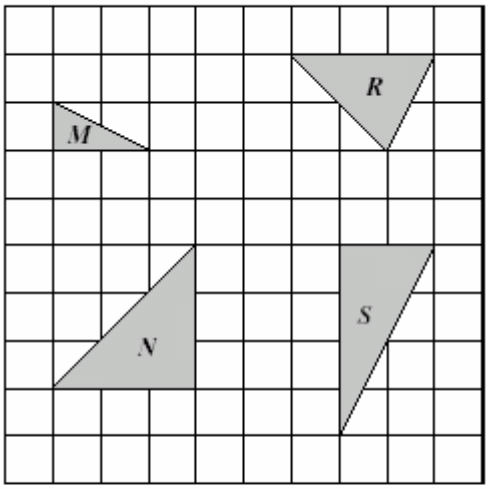
GROUP THREE

Rectangle	Width	Length

Name: _____

Reflecting on Similar Figures

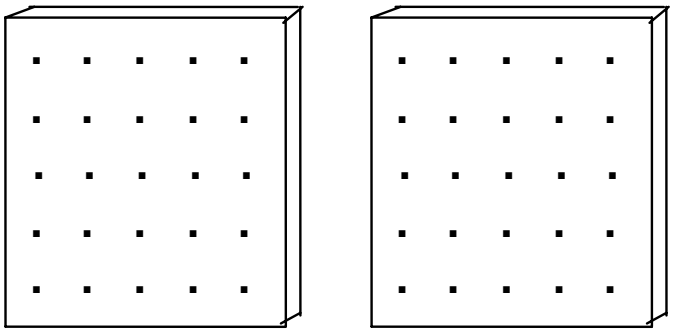
Four triangles are shown on the grid below.

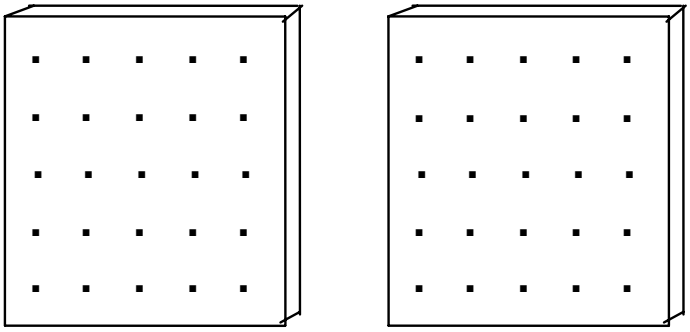


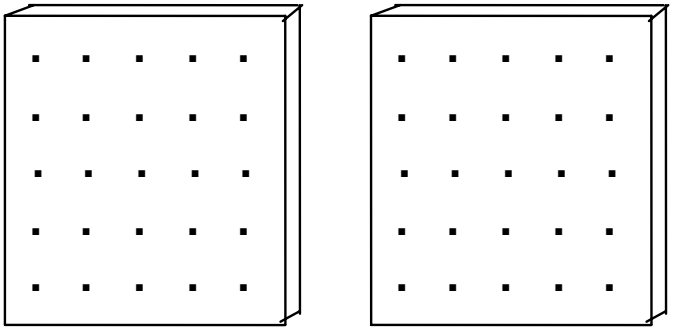
Which two triangles appear to be similar?

F M and S
G M and N
H N and S
J R and N

In the first column below, draw a simple figure. In the second column, draw a figure that is *similar* to the first figure.



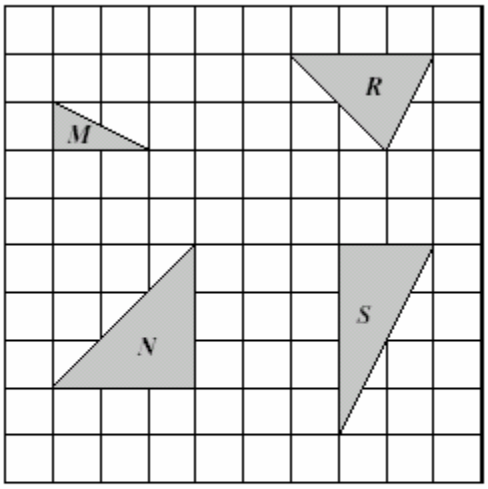




Name: ANSWER KEY

Reflecting on Similar Figures

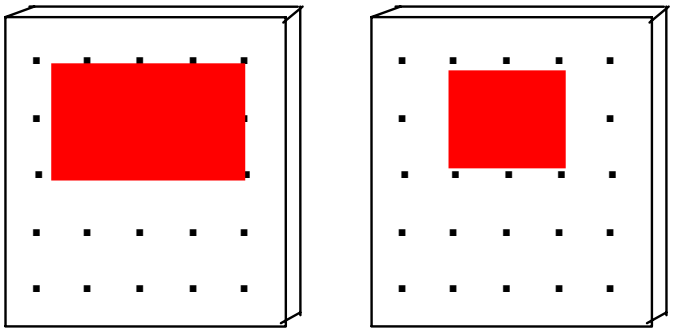
Four triangles are shown on the grid below.

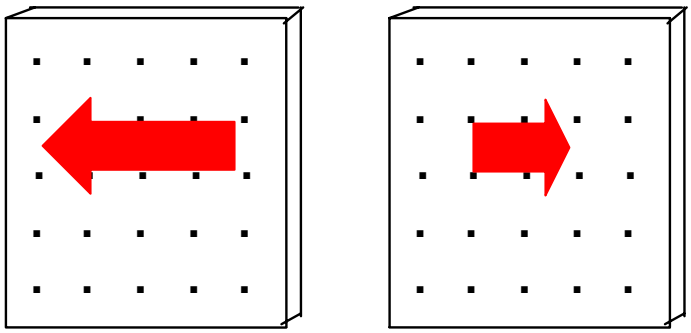


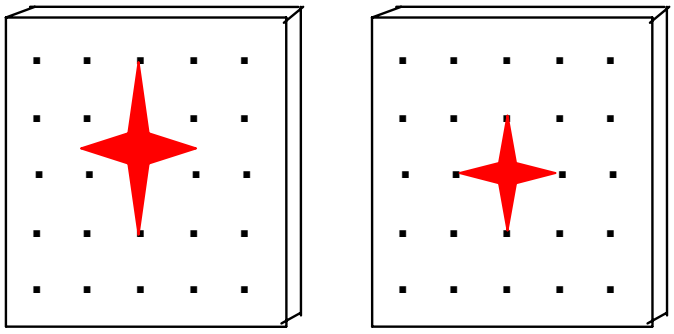
Which two triangles appear to be similar?

F M and S
G M and N
H N and S
J R and N

In the first column below, draw a simple figure. In the second column, draw a figure that is *similar* to the first figure.







✱ SOL 8.8

Prerequisite SOL

7.12

Lesson Summary

Students perform dilations of polygons on the coordinate plane. (30 minutes)

Materials

"Warm-up" worksheets
"Dilations" worksheets
Pencils
Calculators
"Reflecting on Dilations" worksheets

Vocabulary

dilation. A transformation of a geometric figure in which it changes size but keeps its shape.

Warm-up

Have students complete the "Warm-up" worksheet. Give assistance as needed.

Lesson

1. Distribute the "Dilations, Part 1" worksheet. Have students graph the given coordinates A, B, C, and D and connect the dots. Ask, "What shape did you draw?" (rectangle) Have them determine how long sides AB and AD are in grid units and record these lengths in the chart.
2. Ask students to fill in the second row of coordinates by multiplying both coordinates of each point in the first row by 2.
3. Have students predict what they think this new shape will look like. Then, have them plot the new coordinates and label the new coordinates A′, B′, C′, and D′. (The prime sign is used to indicate that a point belongs to an image.) Ask them to describe the new shape. (It is the same shape but larger.) Prompt them to describe exactly how much larger it is (twice as large) by comparing the length of the new side A′B′ to the original side AB, and comparing the length of the new side A′D′ to the original side AD. Explain that they have just performed a dilation, using a scale factor of 2. This means that the figure gets twice as large.
4. Ask students how they think they will perform a dilation of the original figure, using a scale factor of 3. (Multiply both coordinates of each point by 3.) Have them perform the dilation in the same manner, labeling the points A″, B″, C″, and D″.
5. Have students complete the questions on the worksheet.
6. Distribute the "Dilations, Part 2" worksheet. Have students graph the given coordinates and connect the dots. Ask, "What shape did you draw?" (pentagon)
7. Explain that this time they will perform a dilation using a scale factor of ½. Ask them how they think they will accomplish this task. (Multiply both coordinates of each point by ½ or 0.5.) Have them perform the dilation in the same manner and complete the questions on the worksheet.

Reflection

Have students complete the "Reflecting on Dilations" worksheet.

Name: _____

Warm-up

1. Make a list of real-life situations in which you see “scaled up” or “scaled down” versions of objects.

2. Practice multiplying a fraction by a whole number:

   a. $\frac{1}{2} \cdot 6 =$

   b. $\frac{1}{3} \cdot 12 =$

   c. $\frac{3}{5} \cdot 10 =$

   d. $\frac{1}{4} \cdot 0 =$

Name: ANSWER KEY

Warm-up

1. Make a list of real-life situations in which you see “scaled up” or “scaled down” versions of objects.

   Answers will vary. Possible responses: maps, blueprints, model airplanes, architectural models, toys that are scaled down versions of real objects, images taken from a microscope. photocopies that are enlargements or reductions of the original.

2. Practice multiplying a fraction by a whole number:

   a. $\frac{1}{2} \cdot 6 = 3$

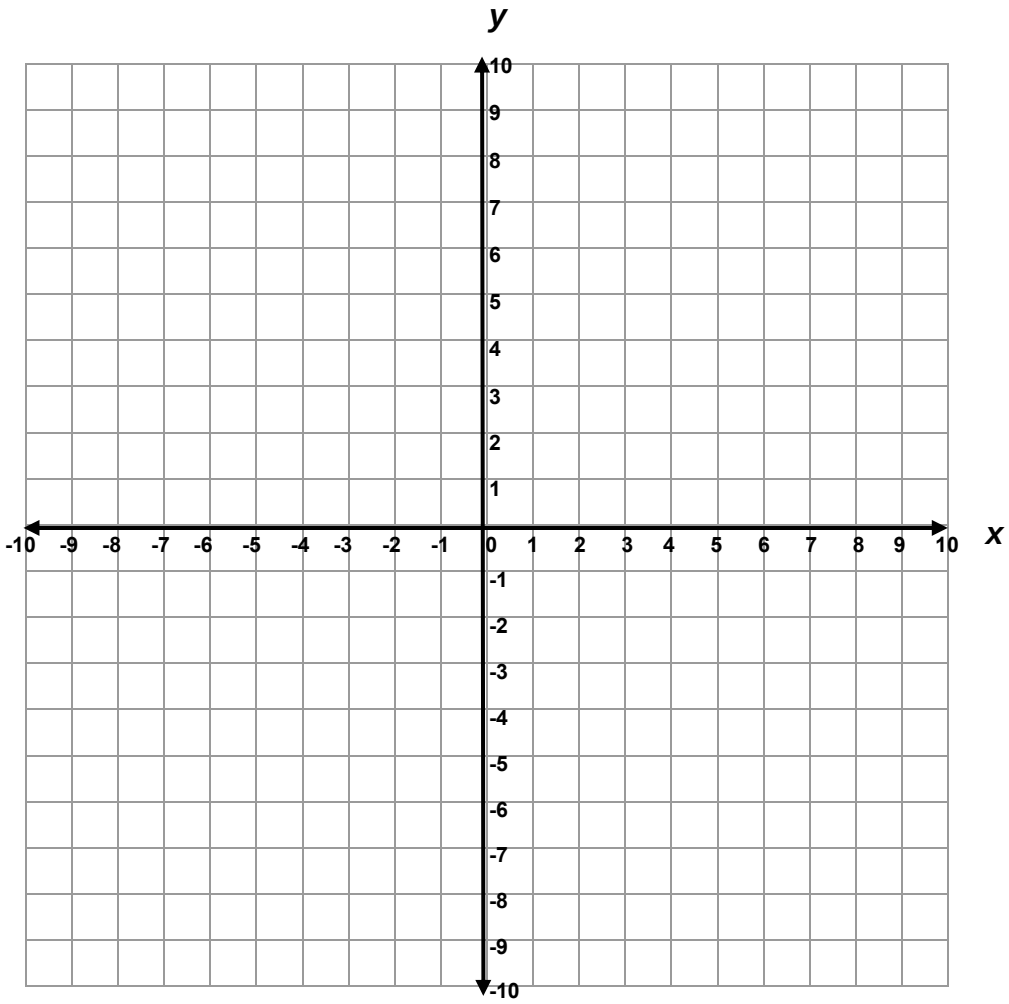
   b. $\frac{1}{3} \cdot 12 = 4$

   c. $\frac{3}{5} \cdot 10 = 6$

   d. $\frac{1}{4} \cdot 0 = 0$

Name: _____

Dilations, Part 1



SCALE FACTOR	COORDINATES				Length of AB	Length of AD
original	**A (-1, -1)**	**B (2, -1)**	**C (2, 3)**	**D (-1, 3)**		
2	**A′ ( )**	**B′ ( )**	**C′ ( )**	**D′ ( )**		
3	**A″ ( )**	**B″ ( )**	**C″ ( )**	**D″ ( )**		

1. What happens to the size of the figure after dilating it, using a scale factor of 2?

   _____

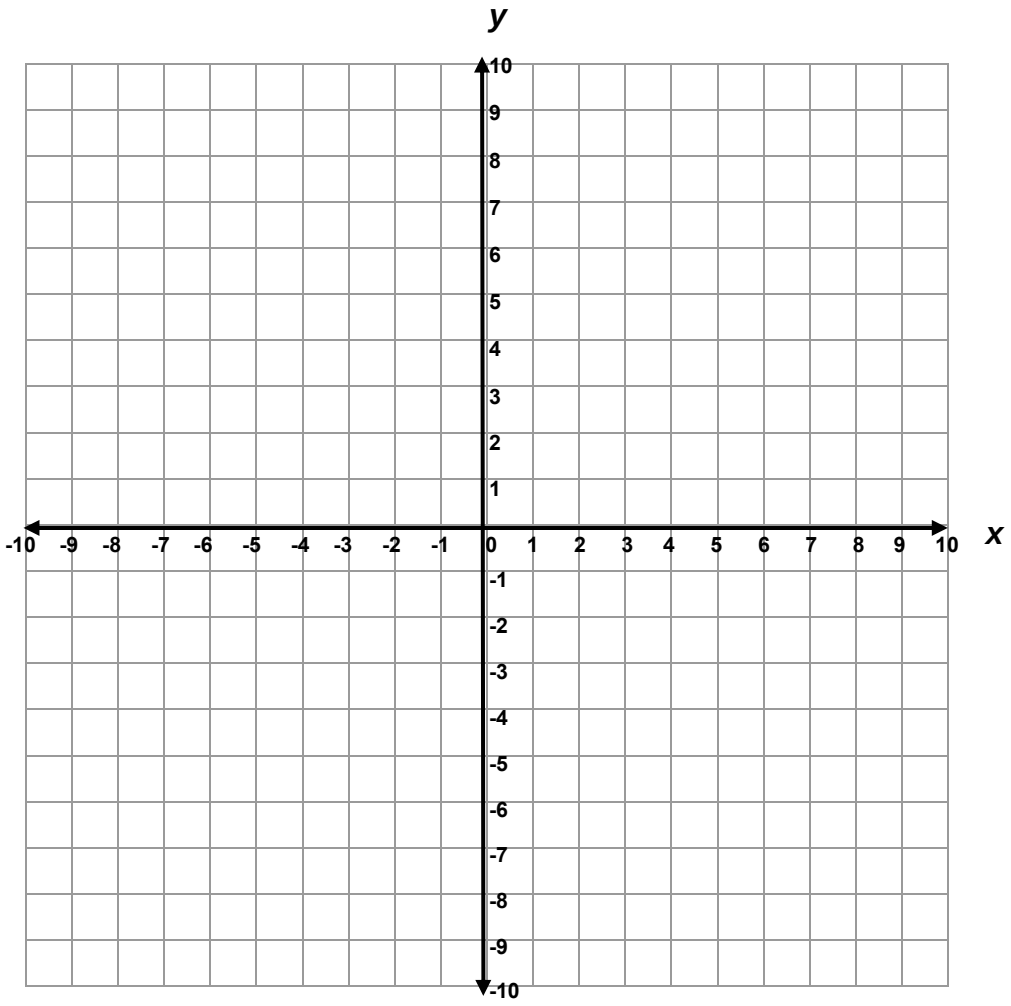
2. What happens to the size of the figure after dilating it, using a scale factor of 3?

   _____

3. Does a dilation cause the shape to change? _____

Name: _____

Dilations, Part 2



SCALE FACTOR	COORDINATES				
original	**A (0, 4)**	**B (4, 0)**	**C (8, 4)**	**D (10, 10)**	**E (4, 8)**
½	**A′ ( )**	**B′ ( )**	**C′ ( )**	**D′ ( )**	**E′ ( )**

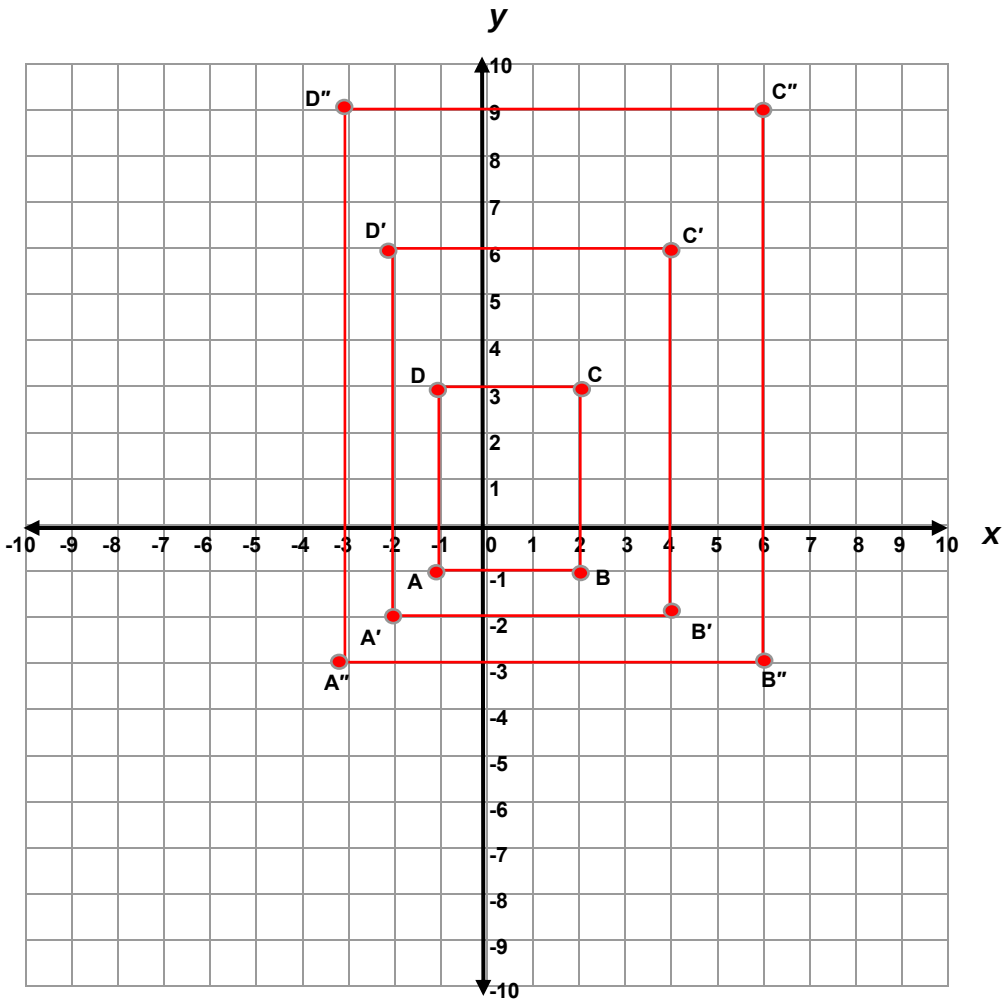
1. What happens to the size of the figure after dilating it, using a scale factor of ½?

   _____

2. Did the shape change? _____

Name: ANSWER KEY

Dilations, Part 1

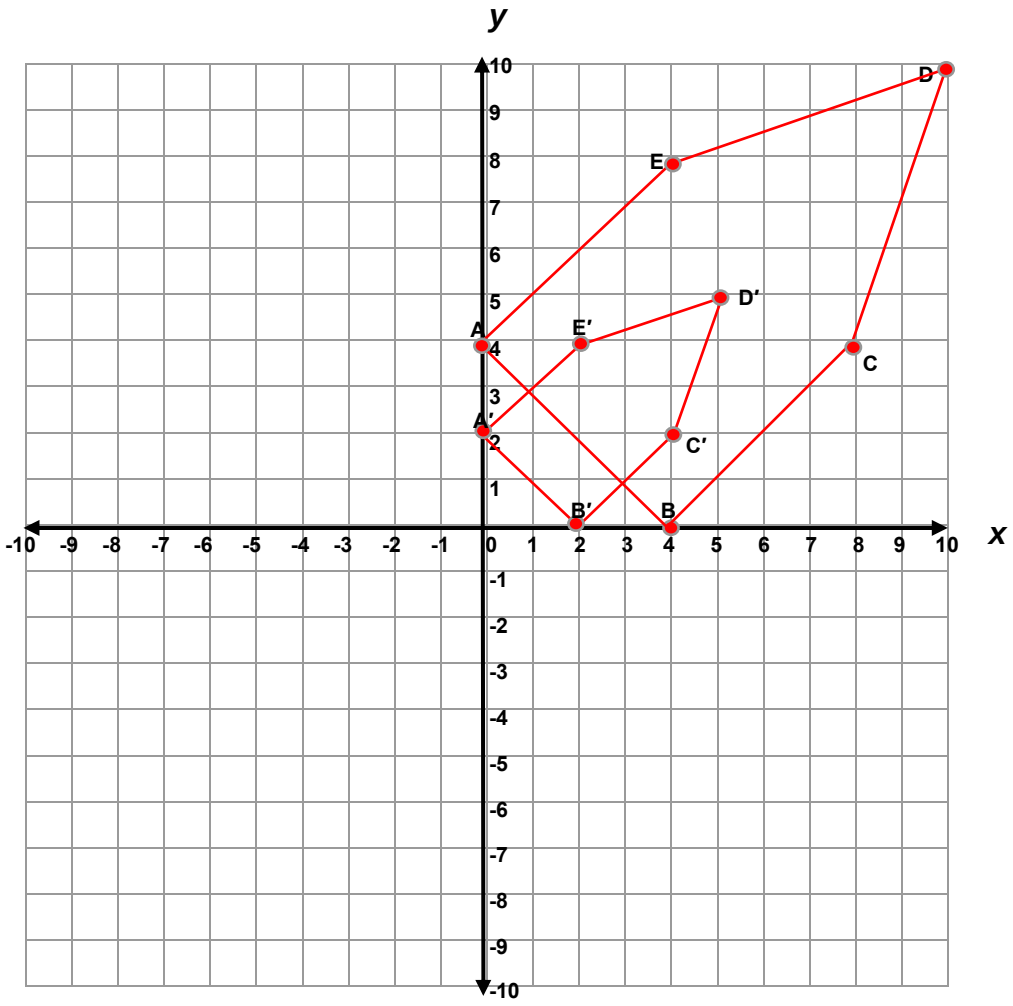


SCALE FACTOR	COORDINATES				Length of AB	Length of AD
(original)	A (-1, -1)	B (2, -1)	C (2, 3)	D (-1, 3)	3 units	4 units
2	A′ (-2, -2)	B′ (4, -2)	C′ (4, 6)	D′ (-2, 6)	6 units	8 units
3	A″ (-3, -3)	B″ (6, 3)	C″ (6, 9)	D″ (-3, 9)	9 units	12 units

1. What happens to the size of the figure after dilating it, using a scale factor of 2?
   It gets twice as large.
2. What happens to the size of the figure after dilating it, using a scale factor of 3?
   It gets three times as large.
3. Does a dilation cause the shape to change? No, only the size changes.

Name: ANSWER KEY

Dilations, Part 2



SCALE FACTOR	COORDINATES				
(original)	**A (0, 4)**	**B (4, 0)**	**C (8, 4)**	**D (10, 10)**	**E (4, 8)**
½	**A′** (0, 2)	**B′** (2, 0)	**C′** (4, 2)	**D′** (5, 5)	**E′** (2, 4)

1. What happens to the size of the figure after dilating it, using a scale factor of ½?

   It gets half as large.

2. Did the shape change? No, only the size changes.

Name: _____

Reflecting on Dilations

1. How would you describe a dilation?

_____

2. If you dilate a figure using a scale factor greater than 1, what happens to the figure?

_____

3. If you dilate a figure using a scale factor less than 1, what happens to the figure?

_____

4. If you were to dilate a figure using a scale factor of 1, what do you think would happen to the figure?

_____

Name: ANSWER KEY

Reflecting on Dilations

1. How would you describe a dilation?

   It causes a figure to change in size, but its shape stays the same.

2. If you dilate a figure using a scale factor greater than 1, what happens to the figure?

   It gets bigger.

3. If you dilate a figure using a scale factor less than 1, what happens to the figure?

   It gets smaller.

4. If you were to dilate a figure using a scale factor of 1, what do you think would happen to the figure?

   It would stay the same size.

✱ SOL 7.13, 8.8

Prerequisite SOL

7.12

Lesson Summary

Students draw a polygon on a coordinate plane and perform translations by using patty paper or tracing paper. (45 minutes)

Materials

"Warm-up" worksheets	2 x 2 inch squares of patty paper or tracing paper
"Translations" worksheets	Rulers
Pencils	Scientific calculators
Colored pencils	"Reflecting on Translations" worksheets

Vocabulary

translation. A transformation in which a plane figure is moved (slid) to another location without any change in size or orientation.
reflection. A transformation in which a plane figure is reflected (flipped) across a line, creating a mirror image.
rotation. A transformation in which a plane figure is rotated (turned) around a fixed center point.
pre-image. An original figure.
image. A translated figure.

Warm-up

Have the students complete the **"**Warm-up" worksheet, offering assistance as needed.

Lesson

1. Prepare a transparency of the "Translations" worksheet for demonstration purposes.
2. Distribute the "Translations" worksheet, and have students use a regular pencil to draw the pre-image ABCD by graphing the coordinates given and connecting the dots. Make sure they label points A, B, C, and D on the coordinate plane and label the figure "Pre-Image."
3. Give students patty paper or tracing paper, and ask them to trace the figure ABCD along with the labels.
4. Explain that a translation is a "slide" of a figure along an imaginary "train track." The figure travels along a straight line in any direction but never rotates as it moves. Demonstrate on the overhead by sliding the patty paper figure across the coordinate plane, and then have the students practice doing the same.
5. Ask students to line up their patty paper figure on top of their pre-image on the coordinate plane. Demonstrate what it means to "translate the figure 4 units to the right." You might recommend that they focus their eyes on one of the points as they count spaces across the coordinate plane. Then have students practice doing the translation.
6. Have students use a colored pencil to record the new coordinates for A, B, C, and D. Ask if they notice whether the new coordinates give any clue about the translation they just performed. (Some may notice that all *x*-coordinates increased by 4. If not, just continue with the next step, and encourage students to be on the lookout for any patterns that arise.)
7. Have students use the same colored pencil to connect the new points A, B, C, D on the coordinate plane. Have them label this figure "Image 1" and label the points A′, B′, C′, and D′. (The prime sign is used to indicate that a point belongs to an image.)
8. Have the students use a regular pencil and a ruler to draw arrows from B to B′ and from D to D′. Explain that this represents the "train tracks."

9. Direct students to line up their patty paper figure again on top of their pre-image on the coordinate plane. Demonstrate what it means to "translate the figure 7 units to the left." Ask students to predict what they think will happen to the coordinates. (The *x*-coordinates will decrease by 7.) Then have students perform the translation.
10. Have students use a different colored pencil to record the new coordinates for A, B, C, and D. Ask them to compare this new set of coordinates with the original coordinates. Ask whether their prediction was correct. Have them use calculators to verify that the *x*-coordinates decreased by 7.
11. Have students use the same colored pencil to plot the new coordinates for A, B, C, and D on the coordinate plane. Have them label this figure "Image 2" and again label the points A′, B′, C′, and D′.
12. Have the students use a regular pencil and a ruler to draw again to draw "train tracks" from B to B′, and from D to D′.
13. Have students repeat the process, using different colored pencils, for the "up" (Image 3) and "down" (Image 4) translations, and discuss what they notice about the change in coordinates with each translation. (Translations to the left cause the *x*-coordinates to decrease; translations to the right cause the *x*-coordinates to increase; translations up cause the *y*-coordinates to increase; translations down cause the *y*-coordinates to decrease.)
14. Ask students what they think would happen if a figure translated up *and* right (both *x*- and *y*-coordinates would increase). Have them perform the translation for Image 5.
15. Have students make up their own "double translation" (left or right *and* up or down) that would cause the figure to move to the third quadrant (lower left corner). Have them record this translation under "Image 6" in the table. Make sure they include the number of units (e.g., 10 units left *and* 4 units down). Have them write the new coordinates *first* and then plot the points. Walk around and ask students if the translation turned out the way they planned. If not, have them make adjustments.

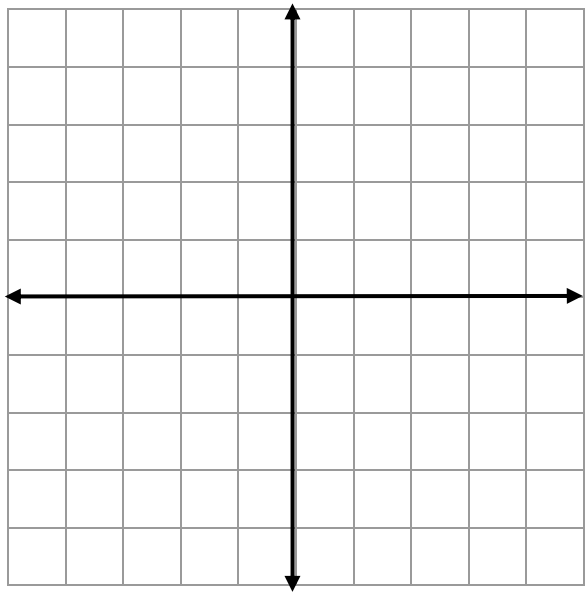
Reflection

Have students complete the "Reflecting on Translations" worksheet.

Name: _____

Warm-up

1. Label and number the *x*-axis and *y*-axis.
2. Graph the following points, and connect the dots as you go: (-3, -1), (2, -1), (4, 1), (-1, 1)



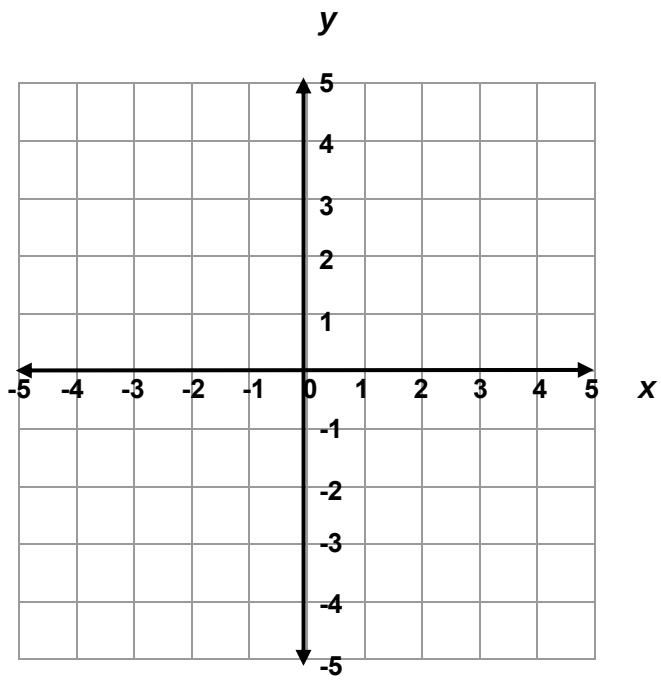
3. What shape did you just draw? _____

Name: ANSWER KEY

Warm-up

1. Label and number the *x*-axis and *y*-axis.

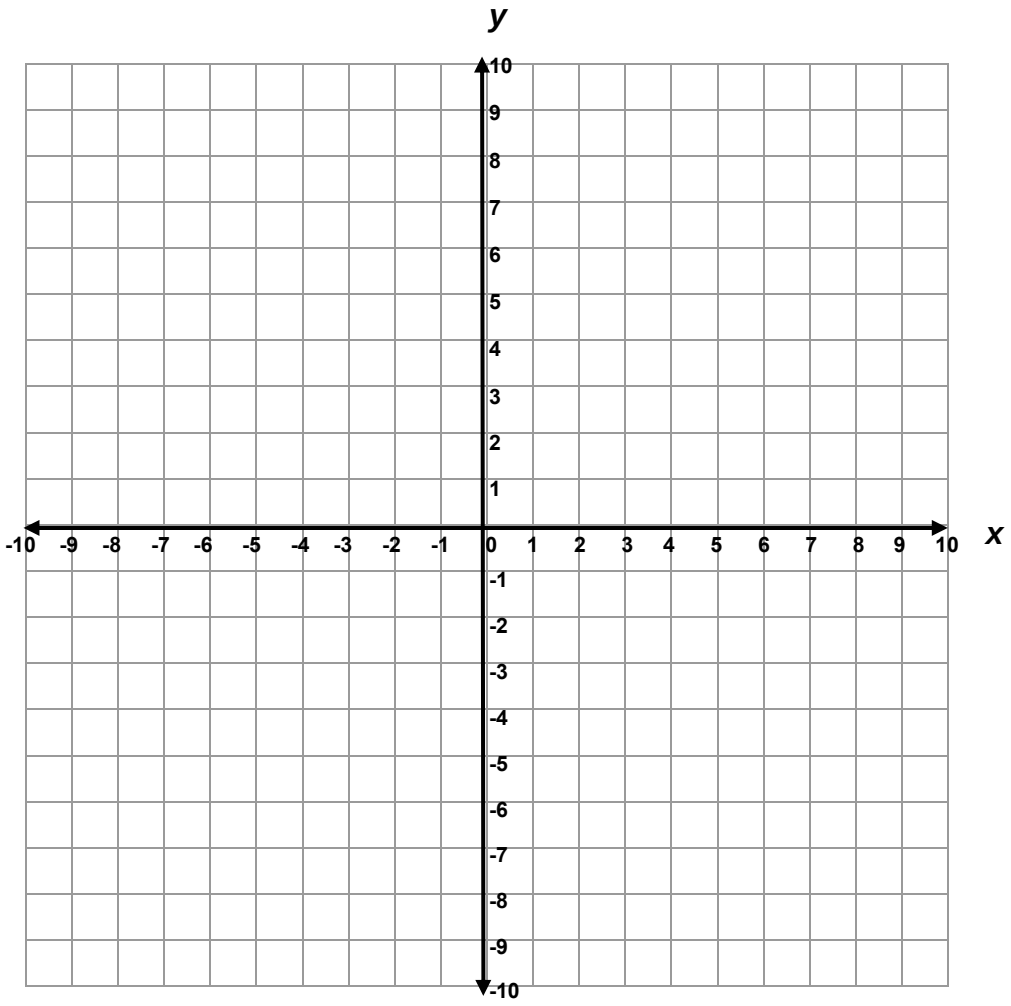
2. Graph the following points, and connect the dots as you go: (-3, -1), (2, -1), (4, 1), (-1, 1)



3. What shape did you just draw? parallelogram

Name: _____

Translations

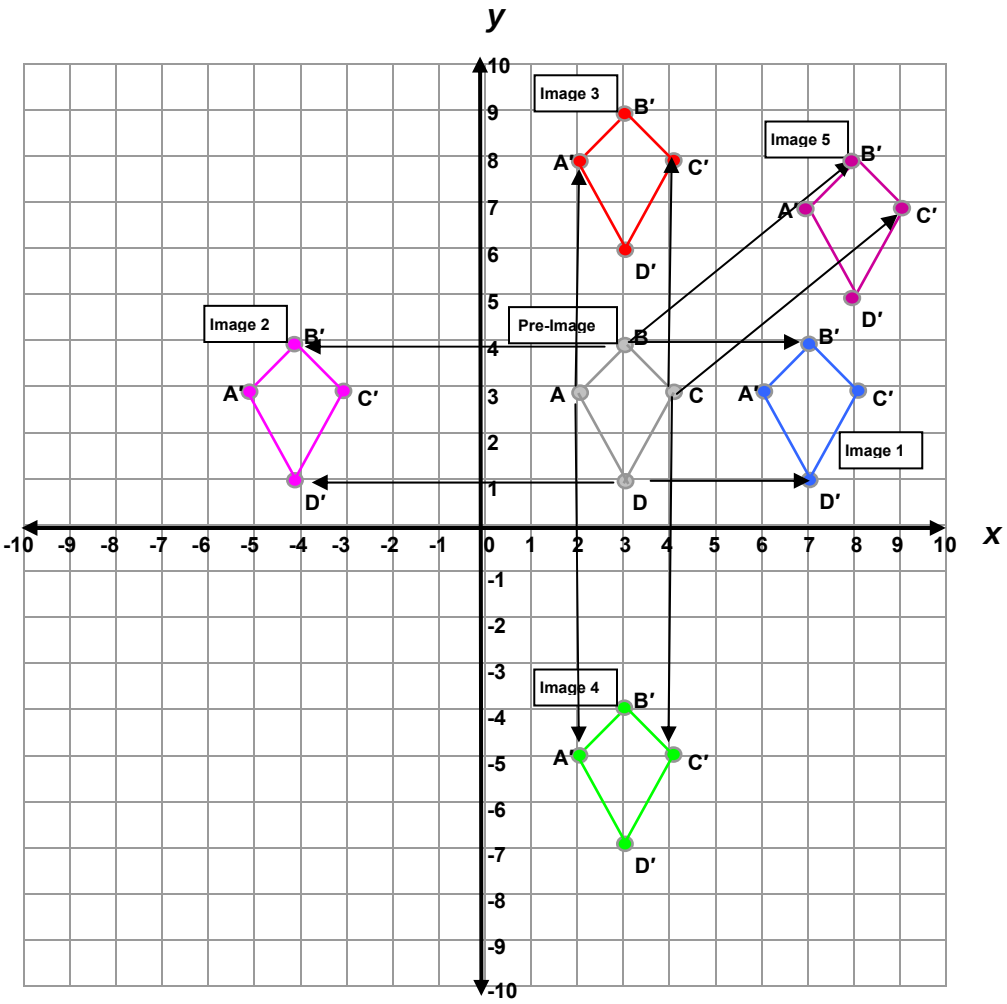


Enter the new coordinates after performing each translation shown below:

IMAGE	ORIGINAL COORDINATES			
	A (2, 3)	B (3, 4)	C (4, 3)	D (3, 1)
Image 1: 4 units right				
Image 2: 7 units left				
Image 3: 5 units up				
Image 4: 8 units down				
Image 5: 5 units right *and* 4 units up				
Image 6 (coordinates of choice in the 3rd quadrant): _____				

Name: ANSWER KEY

Translations



Enter the new coordinates after performing each translation shown below:

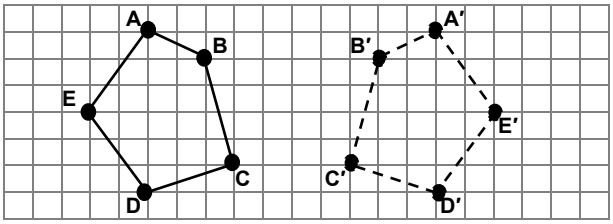
IMAGE	ORIGINAL COORDINATES			
	A (2, 3)	**B (3, 4)**	**C (4, 3)**	**D (3, 1)**
Image 1: **4 units right**	(6, 3)	(7, 4)	(8, 3)	(7, 1)
Image 2: **7 units left**	(-5, 3)	(-4, 4)	(-3, 3)	(-4, 1)
Image 3: **5 units up**	(2, 8)	(3, 9)	(4, 8)	(3, 6)
Image 4: **8 units down**	(2, -5)	(3, -4)	(4, -5)	(3, -7)
Image 5: **5 units right *and* 4 units up**	(7, 7)	(8, 8)	(9, 7)	(8, 5)
Image 6 **(coordinates of choice in the 3rd quadrant):** _____				

Name: _____

Reflecting on Translations

Each figure below shows a transformation. The pre-image is shown with solid lines and the image is shown with dashed lines. Next to each figure, tell whether the transformation shown represents a translation, and then explain why or why not.

1.

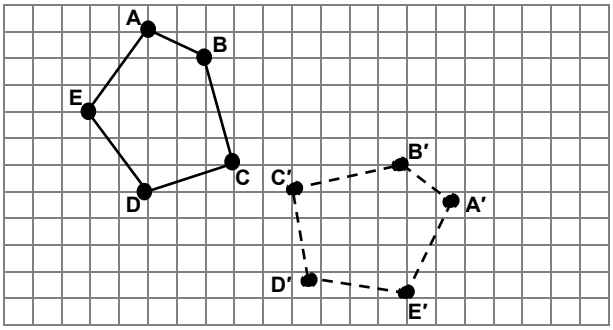


Is this a translation? _____
Explain:

_____

_____

2.

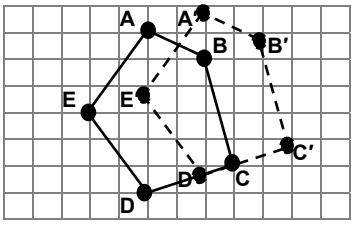


Is this a translation? _____
Explain:

_____

_____

3.

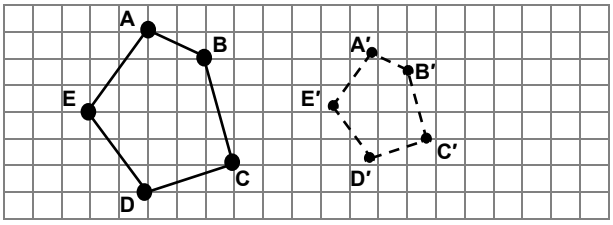


Is this a translation? _____
Explain:

_____

_____

4.



Is this a translation? _____
Explain:

_____

_____

5. When you translate a figure on the coordinate plane, explain how the *x*-coordinate and *y*-coordinate of each point is affected.

_____

_____

6. What happens to the graph of a figure (in what direction and how far does it move) when...
   - 3 is added to the *x*-coordinate? _____
   - 10 is added to the *y*-coordinate? _____
   - 7 is subtracted from the *y*-coordinate? _____
   - 6 is subtracted from the *x*-coordinate? _____
   - 2 is added to the *x*-coordinate *and* 3 is subtracted from the *y*-coordinate?

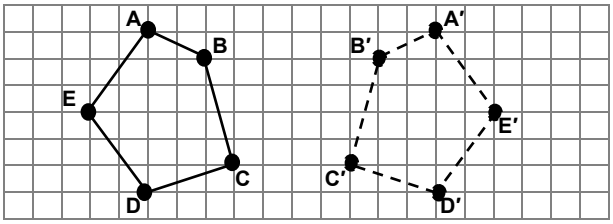
     _____

Name: ANSWER KEY

Reflecting on Translations

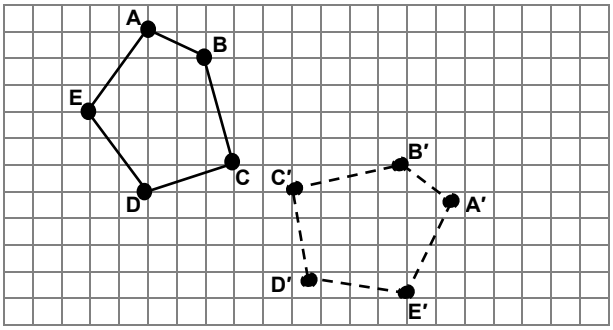
Each figure below shows a transformation. The pre-image is shown with solid lines and the image is shown with dashed lines. Next to each figure, tell whether the transformation shown represents a translation, and then explain why or why not.

1.



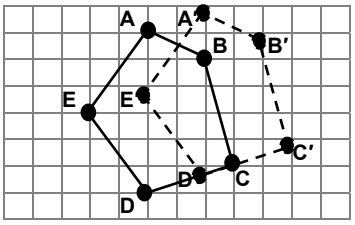
Is this a translation? No
Explain:
The points have moved by different amounts.

2.



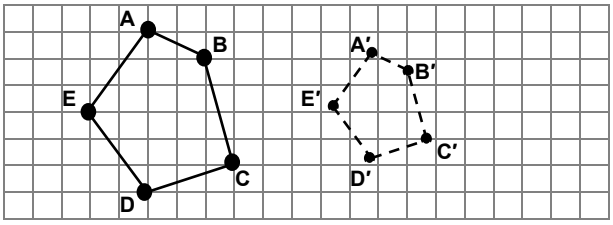
Is this a translation? No
Explain:
The figure has rotated. Also, the points have moved by different amounts.

3.



Is this a translation? Yes
Explain:
All the points have moved right 2 units and up 1 unit. The figure has not rotated.

4.



Is this a translation? No
Explain:
The figure has changed in size. In a translation, the figure remains the same size.

5. When you translate a figure on the coordinate plane, explain how the *x*-coordinate and *y*-coordinate of each point is affected.
   Moving a figure left or right causes the *x*-coordinate to change. Moving a figure up or down causes the *y*-coordinate to change. (Actual responses may vary.)

6. What happens to the graph of a figure (in what direction and how far does it move) when...
   - 3 is added to the *x*-coordinate? It moves 3 units to the right.
   - 10 is added to the *y*-coordinate? It moves 10 units up.
   - 7 is subtracted from the *y*-coordinate? It moves 7 units down.
   - 6 is subtracted from the *x*-coordinate? It moves 6 units to the left.
   - 2 is added to the *x*-coordinate *and* 3 is subtracted from the *y*-coordinate? It moves 2 units to the right *and* 3 units down.

✱ SOL 8.8

Prerequisite SOL

7.12

Lesson Summary

Students draw a polygon on a coordinate plane and use patty paper or tracing paper to perform reflections across the *x*-axis and *y*-axis. (45 minutes)

Materials

5 x 5 inch squares of patty or tracing paper
"Reflections" worksheets
Pencils
Rulers
Tape
"Reflecting on Reflections" worksheets

Vocabulary

reflection. A transformation in which a plane figure is reflected (flipped) across a line, creating a mirror image.

line of reflection. The line across which a figure is reflected (flipped).

Warm-up

Distribute patty paper or tracing paper, and instruct students to fold it in half and draw a picture or write their name on one side of the folded paper. Then, have them then flip the paper over and trace what they drew. Finally, have them unfold the paper. Lead students in describing what happened to their picture. (The second picture is a "backwards" or "flipped" version of the first. It "mirrors" the first on the fold line.

Lesson

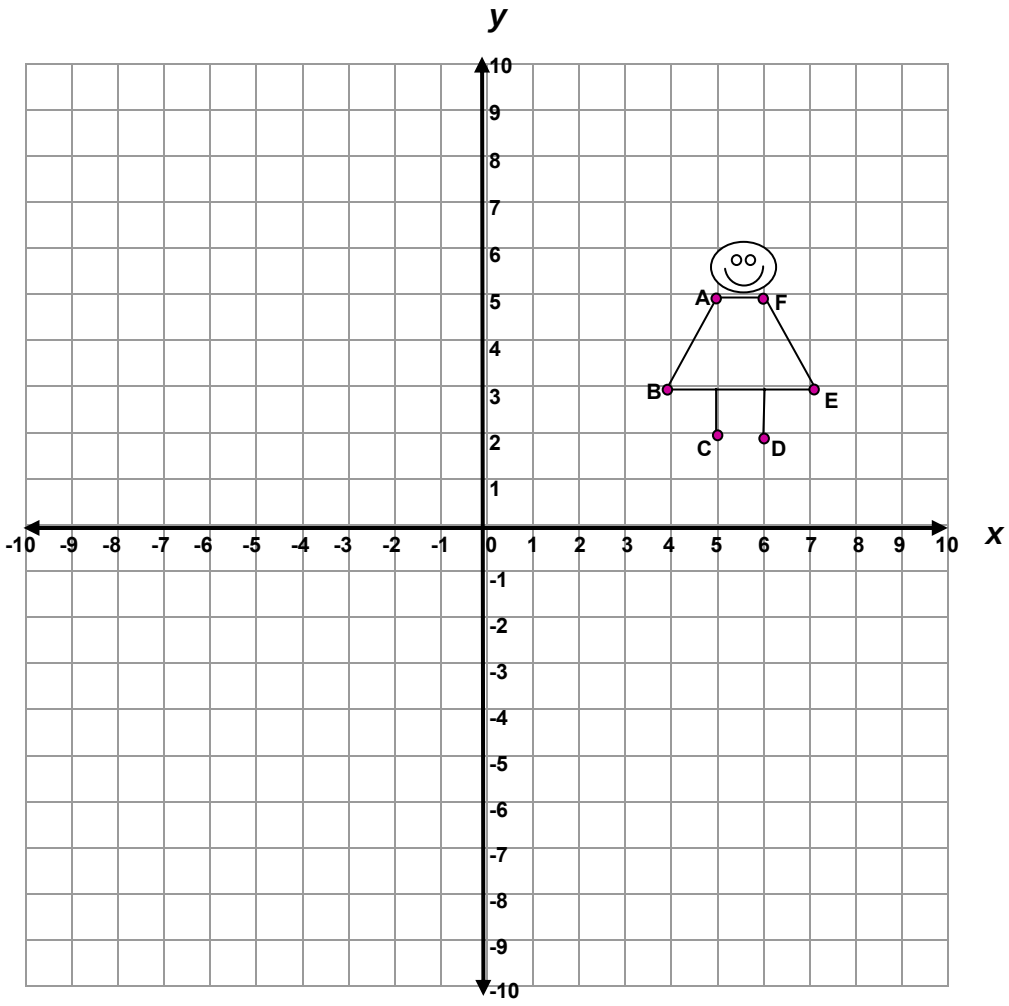
1. Distribute the "Reflections" worksheet. Ask students to enter the coordinates of the figure, as directed in step 1.
2. Explain the procedure for reflecting the image across the *x*-axis — that the *x*-axis will be the line of reflection or mirror line. Ask students to predict what the image will look like.
3. Distribute patty paper. Ask students to trace the *x*-axis, the *y*-axis, and the figure, including the points and the letters.
4. Have students perform a reflection across the *x*-axis by flipping the patty paper over in a downward direction, making sure to keep the *x*-axis and *y*-axis aligned. Have them tape the patty paper in place.
5. Tell students to enter in the second row of the table the coordinates of the reflected image and then to write down what they notice about the these coordinates. (They should see that the *x*-coordinates stay the same, but the *y*-coordinates change signs. Discourage them from saying the *y*-coordinates "go negative," because if the coordinates had been negative to begin with, they would change to positive.)
6. Have students complete steps 3 and 4 of Part 1.
7. Have the students complete Part 2, this time reflecting the figure across the *y*-axis; the patty paper will flip to the left.

Reflection

Have students complete the "Reflecting on Reflections" worksheet.

Name: _____

Reflections, Part 1



1. In the table below, write the coordinates of the figure above and its image after reflecting it across the *x*-axis.

A ( )	**B ( )**	**C ( )**	**D ( )**	**E ( )**	**F ( )**
A′ ( )	**B′ ( )**	**C′ ( )**	**D′ ( )**	**E′ ( )**	**F′ ( )**

2. Compare the sets of coordinates. What do you notice about these pairs?

_____

3. Count how many blocks each point is from the *x*-axis, and list them below:

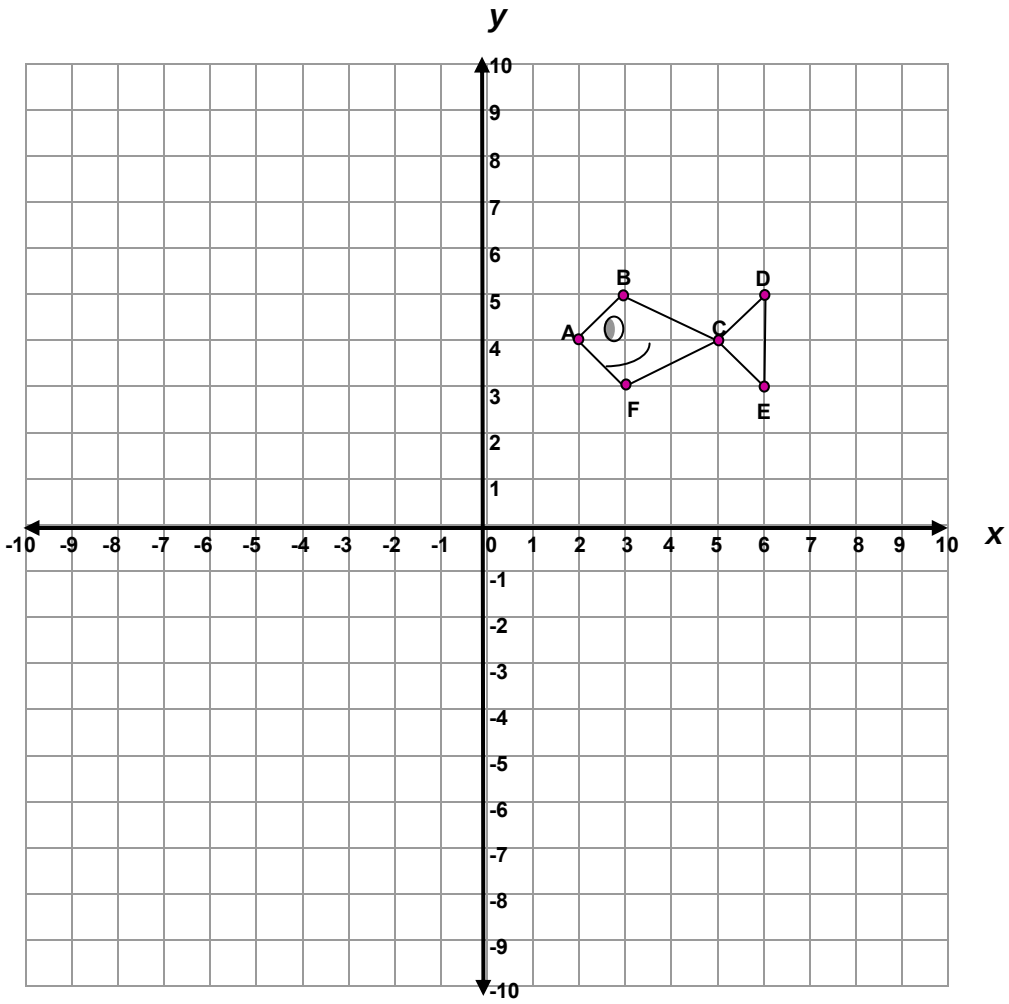
A __5__ **B** _____ **C** _____ **D** _____ **E** _____ **F** _____

A′ _____ **B′** _____ **C′** _____ **D′** _____ **E′** _____ **F′** _____

4. The distance from the mirror line to any point on the figure is _____ (greater than, less than, or equal to) the distance from the mirror line to its *reflected image*.

Name: _____

Reflections, Part 2



1. In the table below, write the coordinates of the figure above and its image after reflecting it across the *y*-axis.

A ( )	**B ( )**	**C ( )**	**D ( )**	**E ( )**	**F ( )**
A′ ( )	**B′ ( )**	**C′ ( )**	**D′ ( )**	**E′ ( )**	**F′ ( )**

2. Compare the sets of coordinates. What do you notice about these pairs?

_____

3. Count how many blocks each point is from the *y*-axis, and list them below:

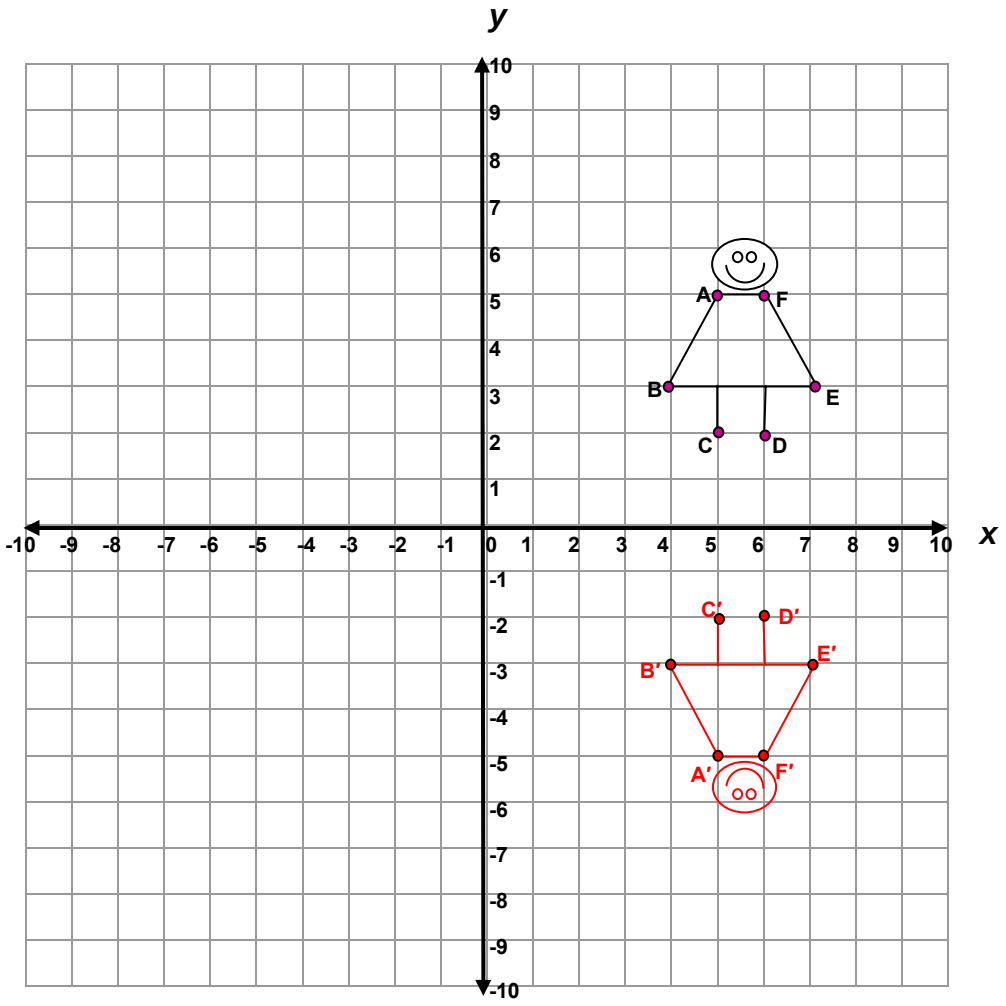
A __2__ **B** _____ **C** _____ **D** _____ **E** _____ **F** _____

A′ _____ **B′** _____ **C′** _____ **D′** _____ **E′** _____ **F′** _____

4. The distance from the mirror line to any point on the figure is _____ (greater than, less than, or equal to) the distance from the mirror line to its *reflected image*.

Name: ANSWER KEY

Reflections, Part 1



1. In the table below, write the coordinates of the figure above and its image after reflecting it across the *x*-axis.

A (5, 5)	**B** (4, 3)	**C** (5, 2)	**D** (6, 2)	**E** (7, 3)	**F** (6, 5)
A′ (5, -5)	**B′** (4, -3)	**C′** (5, -2)	**D′** (6, -2)	**E′** (7, -3)	**F′** (6, -5)

2. Compare the sets of coordinates. What do you notice about these pairs?

   The *x*-coordinates stay the same, but the *y*-coordinates change signs.

3. Count how many blocks each point is from the *x*-axis, and list them below:

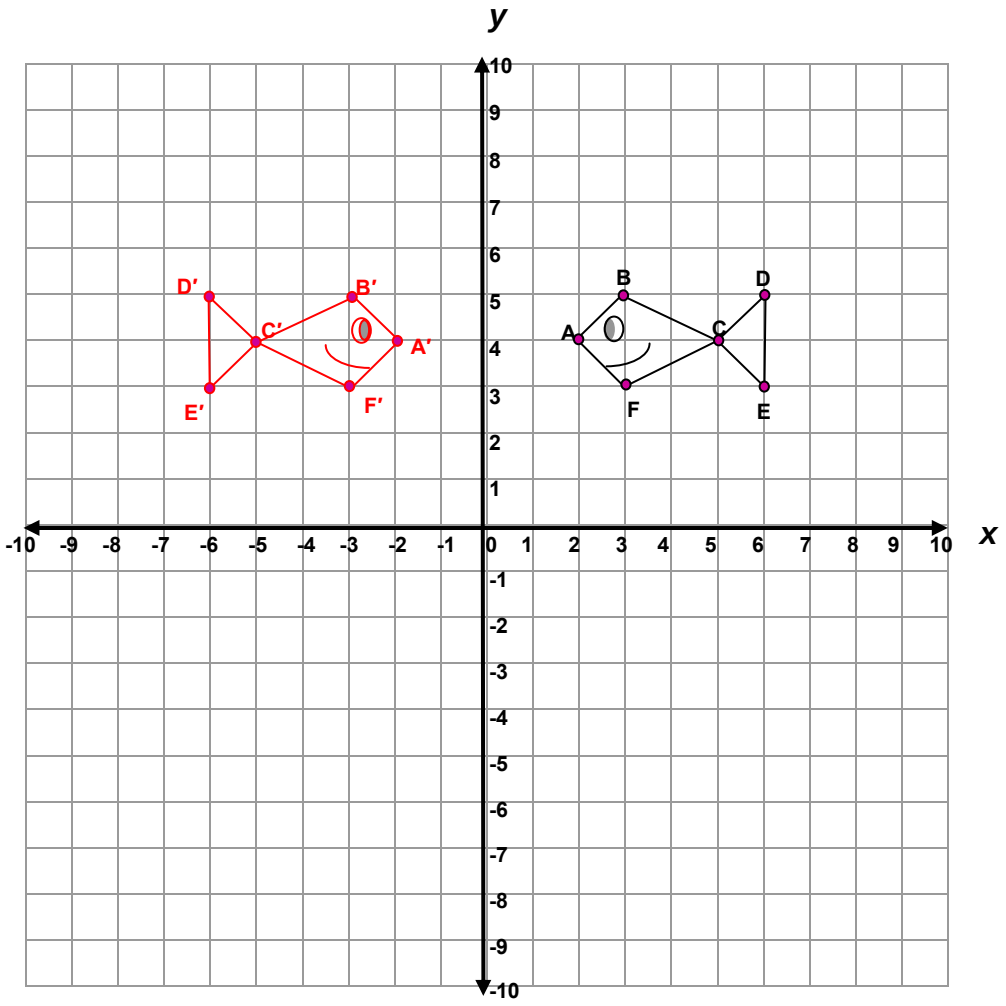
   A 5 **B** 3 **C** 2 **D** 2 **E** 3 **F** 5

   A′ 5 **B′** 3 **C′** 2 **D′** 2 **E′** 3 **F′** 5

4. The distance from the mirror line to any point on the figure is equal to (greater than, less than, or equal to) the distance from the mirror line to its *reflected image*.

Name: ANSWER KEY

Reflections, Part 2



1. In the table below, write the coordinates of the figure above and its image after reflecting it across the *y*-axis.

A (2, 4)	**B** (3, 5)	**C** (5, 4)	**D** (6, 5)	**E** (6, 3)	**F** (3, 3)
A′ (-2, 4)	**B′** (-3, 5)	**C′** (-5, 4)	**D′** (-6, 5)	**E′** (-6, 3)	**F′** (-3, 3)

2. Compare the sets of coordinates. What do you notice about these pairs?

   The *x*-coordinates change signs, but the *y*-coordinates stay the same.

3. Count how many blocks each point is from the *y*-axis, and list them below:

   A 2 **B** 3 **C** 5 **D** 6 **E** 6 **F** 3

   A′ 2 **B′** 3 **C′** 5 **D′** 6 **E′** 6 **F′** 3

4. The distance from the mirror line to any point on the figure is equal to (greater than, less than, or equal to) the distance from the mirror line to its *reflected image*.

Name: _____

Reflecting on Reflections

1. How do the coordinates change when an object is reflected across the *x-axis*?

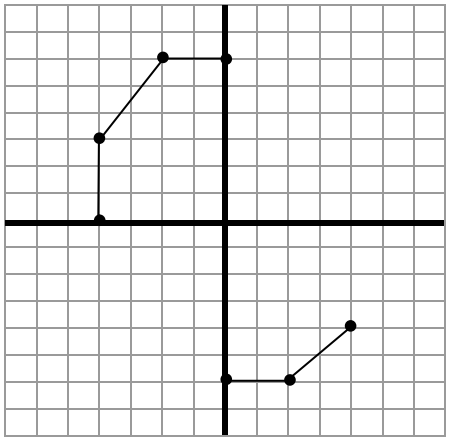
   _____

2. How do the coordinates change when an object is reflected across the *y-axis*?

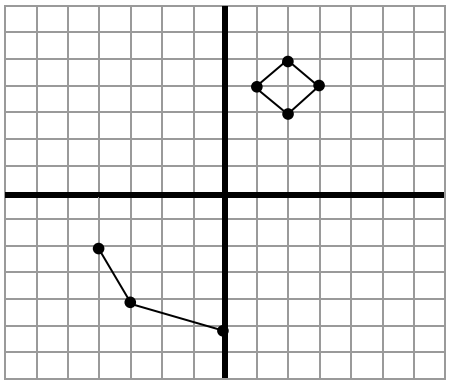
   _____

Use your conclusions above to find the new coordinates for each point:

3. (4, 3) reflected across the *x*-axis _____
4. (-2, 1) reflected across the *y*-axis _____
5. (0, 0) reflected across the *y*-axis _____
6. (-5, -6) reflected across the *x*-axis _____
7. (0, 9) reflected across the *y*-axis _____
8. (0, 9) reflected across the *x*-axis _____
9. (7, 0) reflected across the *y*-axis _____
10. (7, 0) reflected across the *x*-axis _____
11. Reflect the figures below across the *x*-axis.



12. Reflect the figures below across the *y*-axis.



Name: ANSWER KEY

Reflecting on Reflections

1. How do the coordinates change when an object is reflected across the *x-axis*?

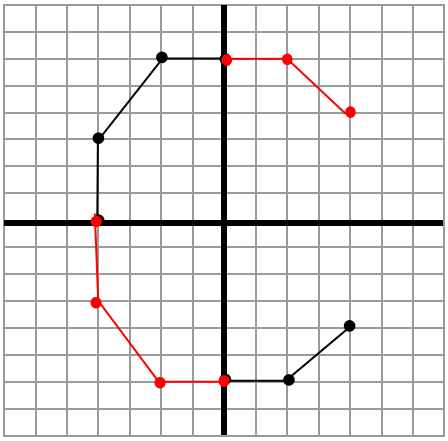
   The *x*-coordinate stays the same, but the *y*-coordinate changes sign.

2. How do the coordinates change when an object is reflected across the *y-axis*?

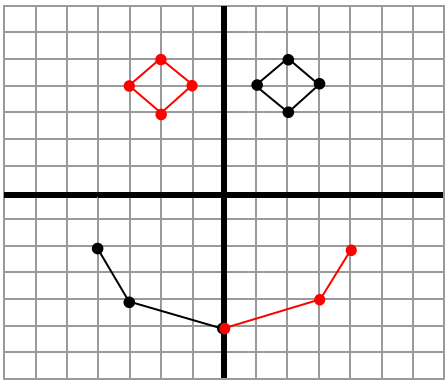
   The *x*-coordinate changes sign, but the *y*-coordinate stays the same.

Use your conclusions above to find the new coordinates for each point:

3. (4, 3) reflected across the *x*-axis (4, -3)
4. (-2, 1) reflected across the *y*-axis (2, 1)
5. (0, 0) reflected across the *y*-axis (0, 0)
6. (-5, -6) reflected across the *x*-axis (-5, 6)
7. (0, 9) reflected across the *y*-axis (0, 9)
8. (0, 9) reflected across the *x*-axis (0, -9)
9. (7, 0) reflected across the *y*-axis (-7, 0)
10. (7, 0) reflected across the *x*-axis (7, 0)
11. Reflect the figures below across the *x*-axis.



12. Reflect the figures below across the *y*-axis.



✱ SOL 7.13, 8.8

Prerequisite SOL

6.13, 7.12

Lesson Summary

Students draw a polygon on a coordinate plane and use patty paper and a protractor to perform 90-degree rotations around origin. (45 minutes)

Materials

"Warm-up" worksheets
"Rotations" worksheets
Colored pencils
Protractors
Tape
Patty paper or tracing paper, cut into approximately 5 x 5 inch squares
"Reflecting on Rotations" worksheets

Vocabulary

rotation. A transformation in which a plane figure is rotated (turned) around a fixed center point.
origin. The point (0, 0) on the coordinate plane.
pre-image. An original figure.
image. A translated figure.

Warm-up

Distribute the "Warm-up" worksheet, and allow students ample time to complete it. Review student responses before proceeding with the lesson.

Lesson

1. Distribute the "Rotations" worksheet, protractors, and tape. Have the students tape the worksheet to their desk so that it will not move.
2. Instruct the student to use a colored pencil to graph the original coordinates listed in the table. Then, have them use the straightedge of the protractor to connect the coordinates, thus drawing a triangle. They should label the vertices of the triangle A, B, and C in accordance with the letters of the coordinates. Have them write "Pre-image" inside the triangle.
3. Have students use a different colored pencil to draw a dot on the origin of the coordinate plane and then draw a line connecting the origin to point A.
4. Explain to students that they will now rotate the triangle around the origin. To help them grasp this concept, they may find it helpful to think of the following analogies: (1) The origin is like the axle of a tire in that it stays fixed while the triangle rotates around it. (2) The line connecting the origin to point A is like a kite string, and the origin is like a person's hand holding the string.
5. Distribute patty paper, and ask students to place the patty paper over the worksheet so that it covers the origin and the triangle.
6. Have students trace their triangle, along with the A, B, and C labels, using the first colored pencil (same color as the triangle). Have them trace the "kite string," using the other colored pencil.
7. Have students practice rotating by placing their pencil point on the origin and turning the patty paper. Point out that after a rotation, the original kite string and the patty paper kite string form an angle and that this angle represents how "far" the figure has been rotated. Therefore, rotations are measured in degrees. Also, the pre-image can rotate in two directions — clockwise and counterclockwise.
8. Ask students to use estimation to perform a 45° clockwise rotation of the pre-image. You may want them to see how close they got by measuring the angle of rotation with the protractor. In like manner, have them perform a 90° counterclockwise rotation, and a 180° clockwise rotation.

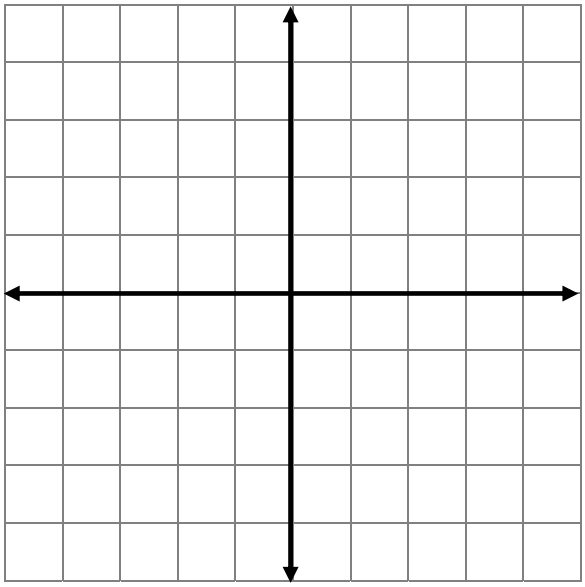
9. Ask students to return their tracing to its original position on top of the original triangle and then to slowly rotate the tracing *counterclockwise*. Tell them to stop rotating when vertex A is located at point (-3, 3).
10. Ask, “How many degrees has the triangle rotated?” (90°) Have students use the protractor to verify the measure of the angle of rotation formed by the two “kite strings.”
11. Have students record in the table the new coordinates for the three points A, B, and C. Ask, “Do you notice any patterns when comparing the new coordinates with the original coordinates?” (For each pair, the new *x*-coordinate is the opposite of the original *y*-coordinate, and the new *y*-coordinate is the same as the original *x*-coordinate.)
12. Ask students to set the patty paper aside, graph the new coordinates on the coordinate plane, and connect the dots. Have them add prime marks to the vertex letters (A’, B’, and C’) to indicate these are the vertices of an *image*. Have them write “90° image” inside the new triangle.
13. Have the students continue in the same manner to perform a 180° rotation [point A at (-3,-3)], a 270° rotation [point A at (3, -3)], and a 360° rotation [point A again at (3, 3)].

Reflection

Have students complete the “Reflecting on Rotations” worksheet.

Name: _____

Warm-up



Part I

1. Label and number the *x*-axis and the *y*-axis.

2. Graph the following points, and connect them as you go: (2, 0), (-1, -1), (-3, 2) (0, 5), (3, 3).

3. What shape did you just draw? _____

Part II

4. Stand up, face a wall, and hold your arm straight in front of you. While standing in the same spot, turn your body to the left. How many degrees did you just rotate? _____ Did you rotate clockwise or counterclockwise? _____

5. Return to your original standing position with your arm straight in front of you. While standing in the same spot, turn your body to right all the way around until you are back in the position where you started. How many degrees did you just rotate? _____ Did you rotate clockwise or counterclockwise? _____

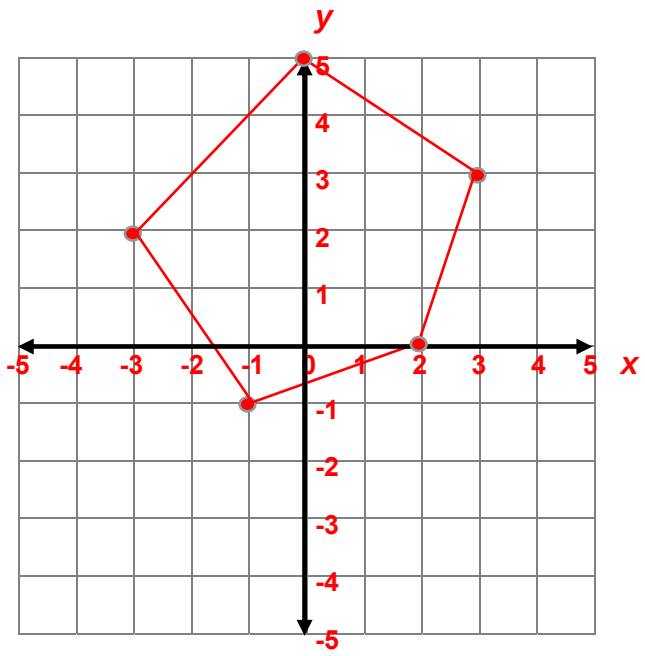
6. Write a list of things that ordinarily rotate or turn.

_____

_____

Name: ANSWER KEY

Warm-up



Part I

1. Label and number the *x*-axis and the *y*-axis.

2. Graph the following points, and connect them as you go: (2, 0), (-1, -1), (-3, 2) (0, 5), (3, 3).

3. What shape did you just draw? ___pentagon_____

Part II

4. Stand up, face a wall, and hold your arm straight in front of you. While standing in the same spot, turn your body to the left. How many degrees did you just rotate? __90°__ Did you rotate clockwise or counterclockwise? __counterclockwise__

5. Return to your original standing position with your arm straight in front of you. While standing in the same spot, turn your body to right all the way around until you are back in the position where you started. How many degrees did you just rotate? __360°__ Did you rotate clockwise or counterclockwise? __clockwise__

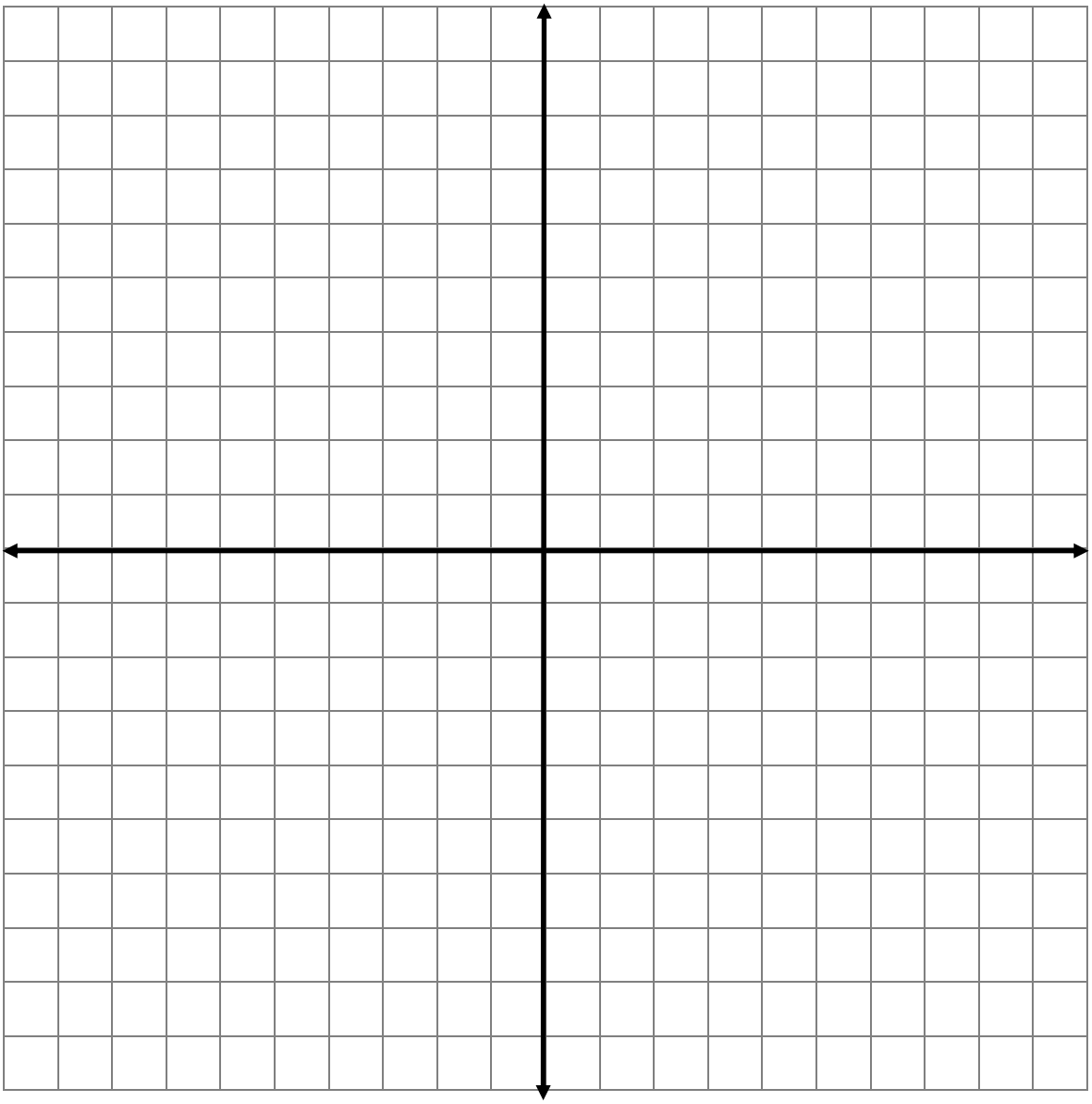
6. Write a list of things that ordinarily rotate or turn.

   Possible responses: tire, merry-go-round, ferris wheel, fan, propeller, a hand on a clock

Name: _____

Rotations

Follow the verbal directions of your teacher to complete this worksheet.

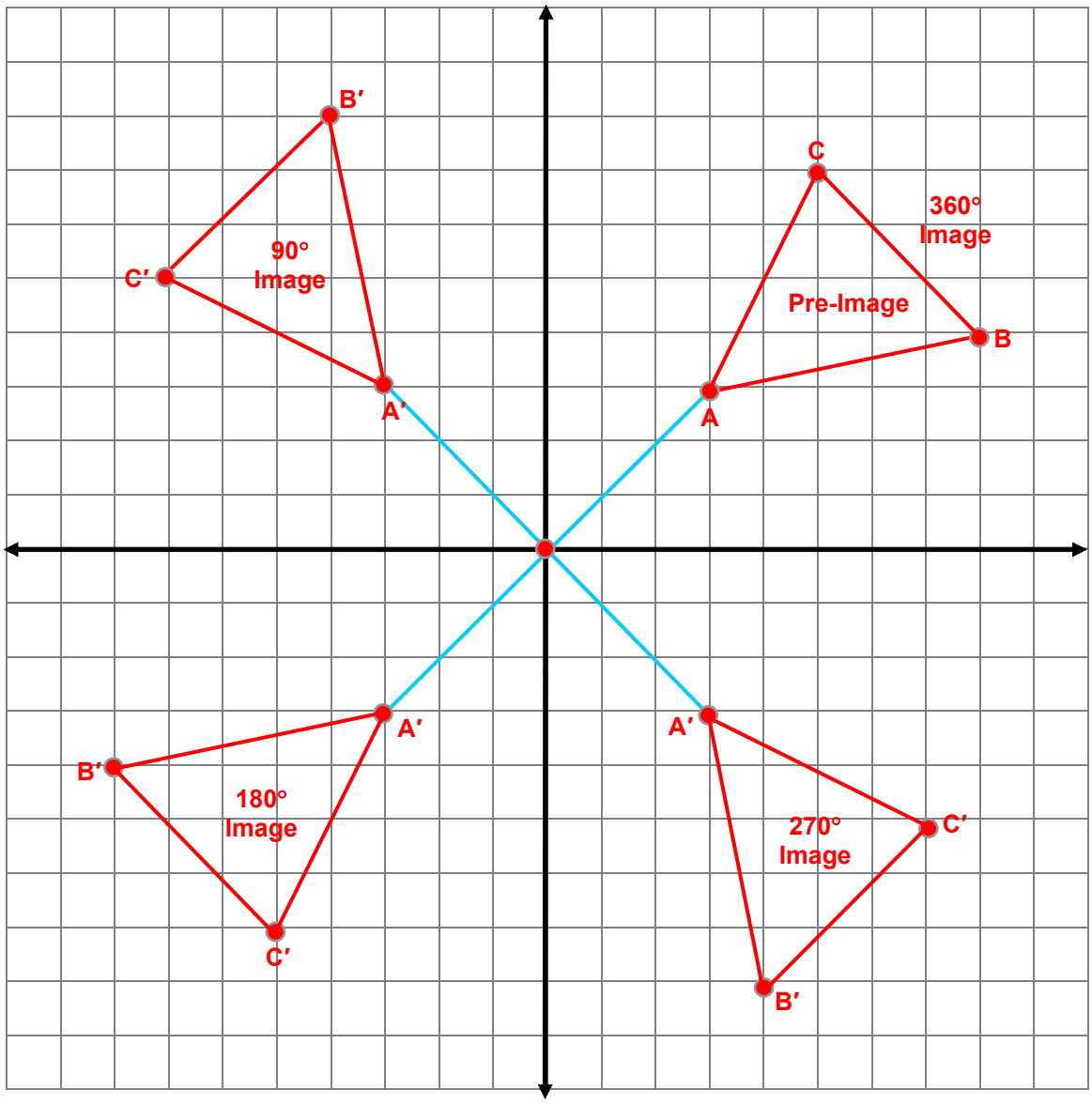


Original Coordinates	90° Rotation	180° Rotation	270° Rotation	360° Rotation
A (3 , 3)	_____	_____	_____	_____
B (8 , 4)	_____	_____	_____	_____
C (5 , 7)	_____	_____	_____	_____

Name: ANSWER KEY

Rotations

Follow the verbal directions of your teacher to complete this worksheet.



Original Coordinates	90° Rotation	180° Rotation	270° Rotation	360° Rotation
A (3 , 3)	(-3, 3)	(-3, -3)	(3, -3)	(3, 3)
B (8 , 4)	(-4, 8)	(-8, -4)	(4, -8)	(8, 4)
C (5 , 7)	(-7, 5)	(-5, -7)	(7, -5)	(5, 7)

Name: _____

Reflecting on Rotations

1. When a figure is rotated on the coordinate plane, does its shape change? _____

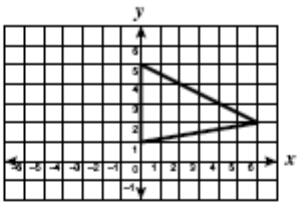
2. At right is a sample SOL test question related to rotations. How could you use patty paper to help answer the question?

   _____

   _____

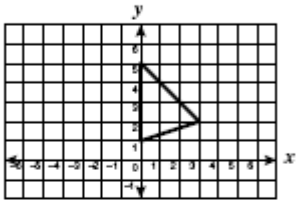
3. Which answer is correct? _____

The diagram below shows a geometric figure on a coordinate plane.

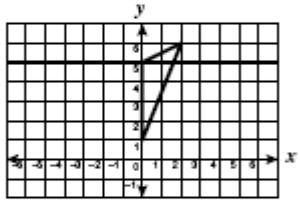


Which of the diagrams below shows a rotation of this geometric figure?

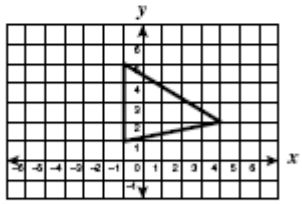
F



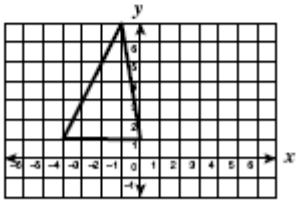
G



H



J



Name: ANSWER KEY

Reflecting on Rotations

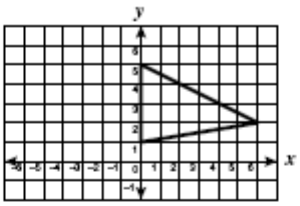
1. When a figure is rotated on the coordinate plane, does its shape change? ___no___

2. At right is a sample SOL test question related to rotations. How could you use patty paper to help answer the question?

   You could trace the original pre-image on the patty paper and then put the patty paper over each answer image, rotating the tracing to see if the answer image is a rotation.

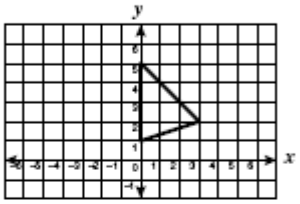
3. Which answer is correct? __J__

The diagram below shows a geometric figure on a coordinate plane.



Which of the diagrams below shows a rotation of this geometric figure?

F



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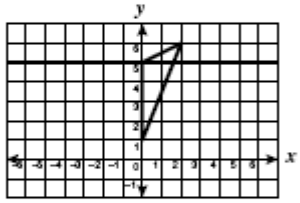

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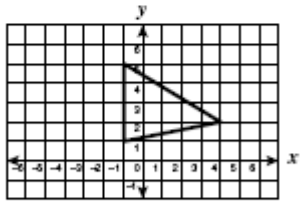

J